



D8 Report:

## Review report on support schemes for renewable electricity and heating in Europe

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The core objective of the RE-Shaping project is to assist member state governments in preparing for the implementation of Directive 2009/28/EC and to guide a European policy for RES in the mid to long term. The past and present success of policies for renewable energies will be evaluated and recommendations derived to improve future RES support schemes.

The core content of this collaborative research activity comprises:

- Developing a comprehensive policy background for RES support instruments.
- Providing the European Commission and member states with scientifically based and statistically robust indicators to measure the success of currently implemented RES policies.
- Proposing innovative financing schemes for lower costs and better capital availability in RES financing.
- Initiation of national policy processes which attempt to stimulate debate and offer key stakeholders a meeting place to set and implement RES targets, as well as options to improve the national policies fostering RES market penetration.
- Assessing options to coordinate or even gradually harmonise national RES policy approaches.

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### *This report*

*aims to summarize the recent development of renewable energy policies in the EU-27*

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## 1 Summary for policymakers

The last decade was characterized by the successful deployment of renewable energy sources (RES) across EU member states - total RES deployment increased by more than 40%. In more detail:

- RES electricity generation grew by approximately 40%, RES heat supply by 30% and biofuels by a factor of 27 during the last decade,
- new renewables in the electricity sector (all technologies except hydropower) increased fivefold during the same period,
- total investments increased to about € 40 billion annually in 2009, and
- more than 80% of all RES investments in 2009 were in wind and PV.

This is the result of a combination of strong national policies and the general focus on renewables created by the EU Renewable Energy Directives in the electricity and transport sectors for 2010 (2001/77/EC and 2003/30/EC).

Despite the challenges posed by the financial and economic crisis, RES investment has increased even further over the last two years. The European Climate Package is one of the key factors that contributed to this development. The EU ETS Directive has introduced full auctioning post 2012, thus exposing fossil power generation to the full cost of carbon allowances. As a result, it has become less attractive for utilities to continue to pursue conventional power projects, and attention has shifted to renewable energy options. The renewable energy trajectory was set and accepted by all European governments, the European Commission and the European Parliament in April 2009 (2009/28/EC). It involves binding RES targets for each member state, based on an equal RES share increase modulated by member state GDP. This provides a clear framework and vision for renewable technologies.

Implementing the 2020 RES Directive has taken another step forward with the formulation of the National Renewable Energy Action Plans (NREAPs), which outline the national strategies concerning support schemes, cooperation mechanisms and barrier mitigation, in particular with respect to grid-related and administrative issues. In addition, a detailed reporting framework for the European Commission and member states has been drawn up to ensure that these strategies are well established and coordinated.

Despite the successful development of the RES sector over the last decade, substantial challenges still lie ahead. For RES-E and RES-H, the growth rate of total generation has to continue in line with the trend observed during the last three years. Compared to the last decade, growth in RES-E needs to almost double from 3.4% per year to 6.7% per year. There also needs to be a substantial increase in growth in the RES-H sector from the 2.7% per year achieved over the last decade to 3.9% per year until 2020. Therefore, the EU as a whole should continue to uphold the past level of achievement and the most successful countries could even over-achieve the 2020 targets by continuing to follow the present trend.

With the successful deployment of RES technologies, the total costs of renewable energy support also increased to about € 35 billion in 2009 or 0.3% of European GDP. As deployment volumes will have to increase still further, it is clear how important it is to continuously review

and improve the policy framework. We discuss the implications separately for (i) deployment policy (ii) power market design and grid infrastructure and (iii) European cooperation.

### (i) Deployment policy

The long-term renewable targets can only be achieved with a portfolio of renewable technologies. Member states react to this challenge by changing and fine-tuning support schemes based on the empirical evidence collected in the EU. We see national policies increasingly focusing on providing tailored support for a set of technologies (e.g. banding in the United Kingdom and Italy, massive reduction of support levels for PV in Germany, Spain and other member states). First RES-H building obligations in Spain and Germany and a RES-H feed-in law in the United Kingdom imply a substantial increase in the policy efforts made in the renewable heating sector.

However, there is still considerable potential for optimization in the current national policies and administration schemes. In a number of member states, technology specifics are still not sufficiently considered in support instruments or in spatial planning. Further progress is needed in several countries to reduce the regulative risk for investors associated also with lengthy permission-granting procedures and to stimulate long-term contracts that offer predictable and reliable prices for energy sales.

### (ii) Power market design and grid infrastructure

Secondly, the role of the EU in power market design as well as the development of grid infrastructure is a field comprising substantial future efficiency gains. The targeted increase of wind and solar power only seems feasible, if the existing infrastructure is used more efficiently with respect to intraday system dispatch, and the right price signals are set for power plant operation and future grid investments. Additionally, the existing grid infrastructure will need to be extended, which will involve strong coordination between EU member states as emphasized in the EU infrastructure package.

### (iii) European cooperation

The cooperation mechanisms set up in the RES Directive are an important instrument in this respect. Developing RES potentials in those member states with lower cost potentials using statistical transfers, joint projects or joint support schemes is seen as a relevant complementary tool for target achievement in some countries. Special interest in using these cooperation mechanisms for target achievement has been expressed by Italy and Luxemburg in their NREAPs. Therefore, the Italian example is considered as a case study in this report. It can be clearly stated that implementing cooperation mechanisms is still just beginning, but this option is being investigated by most member states with great interest. Furthermore the future coordination between member states in defining general design features of support schemes as well as setting tariffs for different technologies might become increasingly important. And, finally, the international trade of biomass also contributes to the flexibility of member states to achieve their targets at moderate costs.

## 2 Development of renewable energies in the EU

This section provides an overview of the current status and the past development of RES in the EU by showing first the overall development of RES in total, and then disaggregated at a sectoral as well as at member state level.

Observing the development of RES technologies in the three final sectors electricity, heat and transport (RES-E, RES-H, RES-T), it becomes clear that the output of RES-H still dominates the renewable final energy mix, representing a proportion of 54% (see Figure 2-1). RES-E generation contributes 38% to total final energy consumption based on RES, whereas the transport sector still plays a marginal role, contributing roughly 9% to final energy use of RES. The overall share of RES in final energy consumption increased from 5.9% in 1990 to 10.2% in 2008. Taking into account the target of 20% by 2020, further strong efforts to stimulate the development of RES technologies are required.

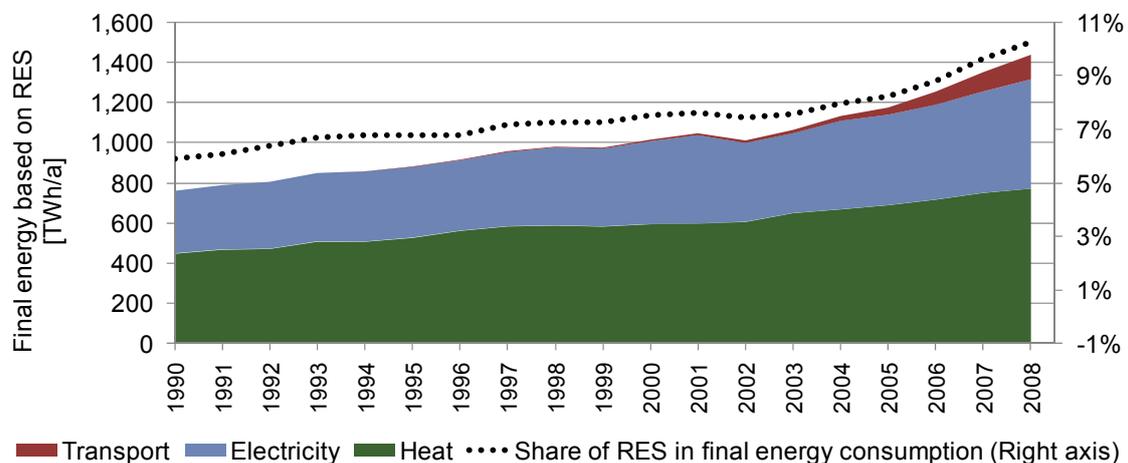


Figure 2-1: Market development of RES technologies according to final energy sector (EU-27)

### 2.1 Electricity

Between 1990 and 2009, the development of RES-E generation in the EU shows a rising trend (Figure 2-2). Hydropower still represents the dominant RES, but has become less important during the last years. This is caused by a strong development of emerging RES-E technologies, such as on-shore wind and biomass. Changing meteorological conditionals led to some fluctuations in the electricity output from hydropower plants (see Figure 2-2). Focussing on the development of emerging RES-E (all RES-E technologies with the exception of hydropower), electricity generation increased more than tenfold from 19 TWh in 1990 to about 250 TWh in 2009 as a consequence of policy efforts undertaken at European and national levels (cf. Figure 2-3). In particular, wind on-shore and the use of solid biomass contributed significantly to this development. Moreover, in recent years also PV deployment is increasing significantly.

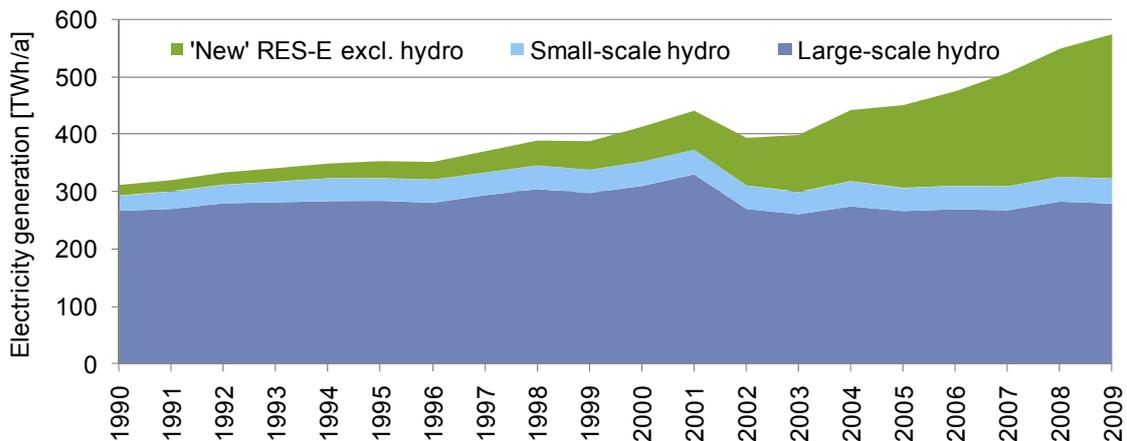


Figure 2-2: Market development of RES in the electricity sector (EU-27)

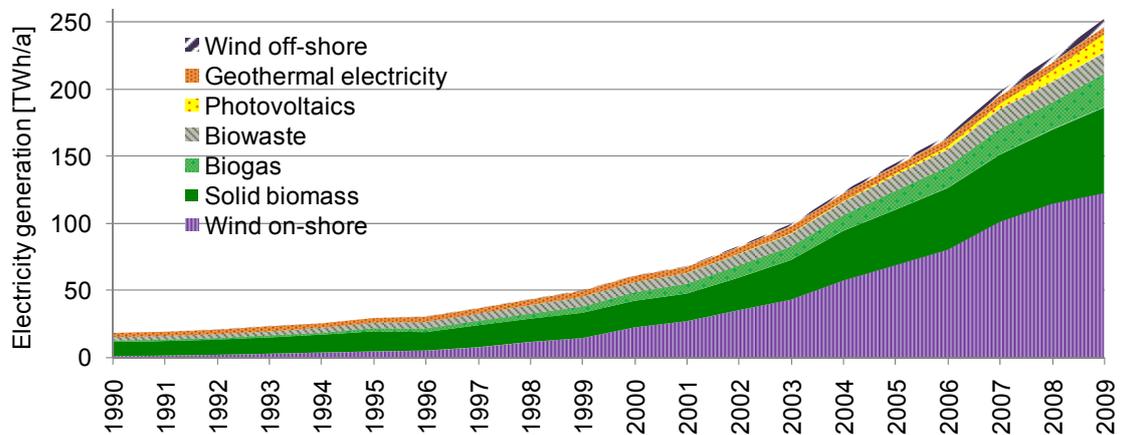


Figure 2-3: Market development of 'new' RES in the electricity sector (EU-27)

## 2.2 Heat

Renewables-based heat generation increased from 452 TWh to 770 TWh between 1990 and 2008, corresponding to an annual growth rate of 3% on average. Most of the renewable heat generated comes from biomass-derived technologies. According to the development shown in Figure 2-4, domestic decentralized heating appliances based on biomass clearly dominate the RES-H market. The use of biomass in centralized heating plants or CHP plants plays an important role in Scandinavian countries, in Lithuania and Austria. Solar thermal heating technologies account only for a very low share of the total amount of RES-heat generated. Similarly, ground source heat pumps and geothermal heating technologies represent only a marginal share of RES-heat production, but are expected to experience further growth in the future. The modest market development of RES-H production, which is in contrast with the development in the electricity as well as in the transport sector, can be explained by the absence of a stable support framework for the support of RES in the heating sector at the European and partially at national levels during the last decade. It now remains to be seen whether the Directive 2009/28/EC positively influences the market development of RES-H technologies.

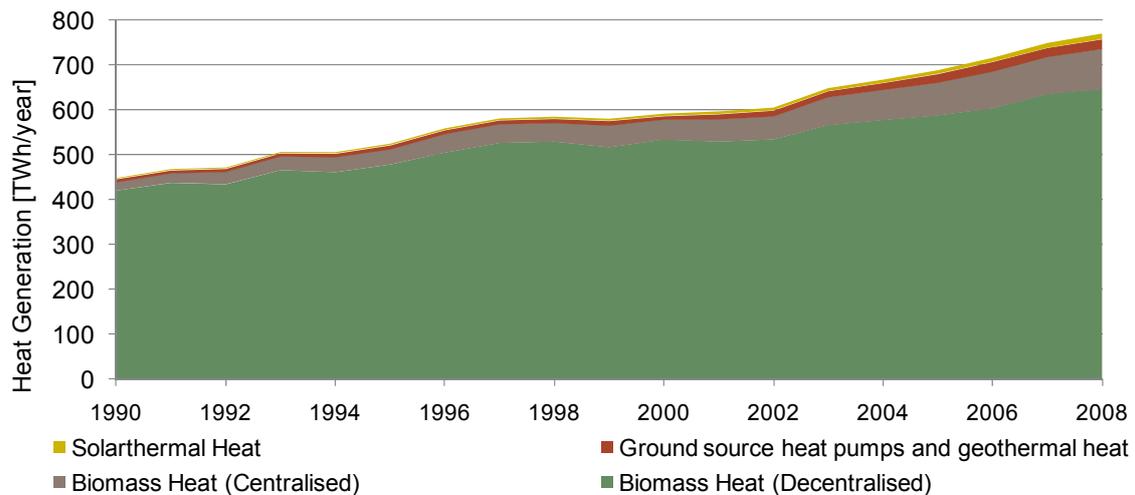


Figure 2-4: Market development of RES in the heating sector (EU-27)

## 2.3 Transport

Triggered by the EU targets set to increase the share of biofuels in transport, biofuel consumption has been developing considerably during the last few years and amounted to 112 TWh by 2008. This value corresponds to 3.5% of total fuel consumption in road transport. Considering the EU target of 5.75% set for 2010, it appears that some political effort is still required if targets are to be met. Biofuel consumption in the EU is clearly dominated by the use of biodiesel which amounted to 78% (of biofuels in total) in 2008. Half of the total amount of bioethanol consumed in the EU during the year 2008 can be attributed to France and Germany. The use of other biofuels, consisting mainly of vegetable oils, amounted to 6% by 2008.

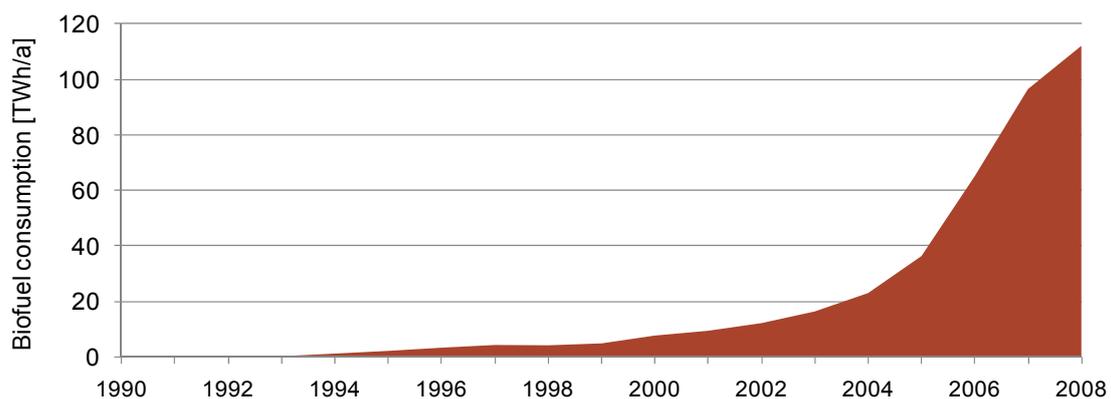


Figure 2-5: Market development of RES in the transport sector (EU-27)

## 2.4 Development at member state level

In this section, we present the current status of renewable energy sources at the member state level. In Figure 2-6 the share of RES in total gross final consumption is shown for the

year 2008 and all EU member states. This figure shows a large variance between countries, with Sweden consuming almost half of the total final energy in form of RES, to Malta which has a share close to zero. Seven member states achieved already today a share of 20% RES in gross final consumption, whereas biomass in the heating sector and hydropower in the electricity sector are still the dominant sources. In most member states, the total RES generation is dominated by renewable heating, followed by RES in the electricity sector. Biofuels in the transport sector show only a minor but quickly growing contribution to RES in total final consumption. In absolute figures, almost 50% of the total final energy from RES is contributed by the three countries Germany, France and Sweden, as can be seen from Figure 2-7.

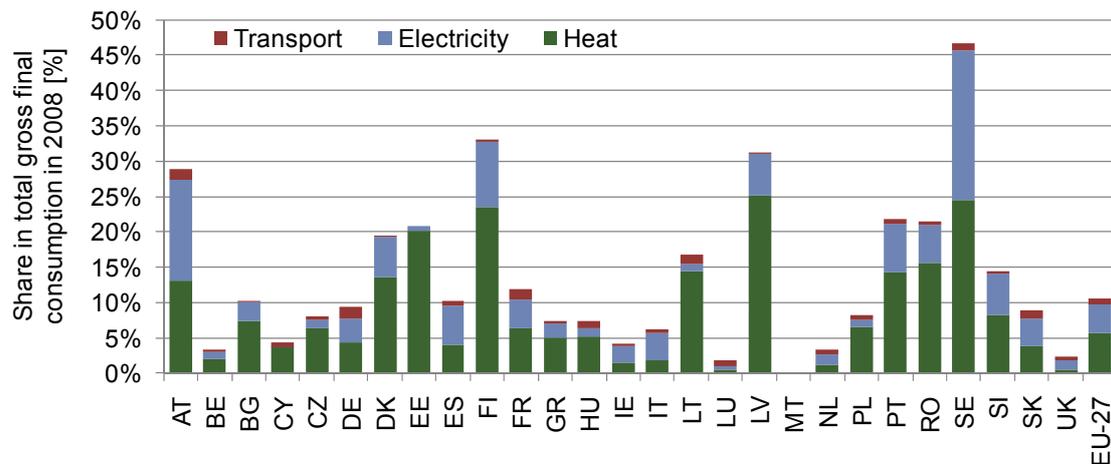


Figure 2-6: Share of RES in total gross final consumption in 2008 (EU-27 member states)

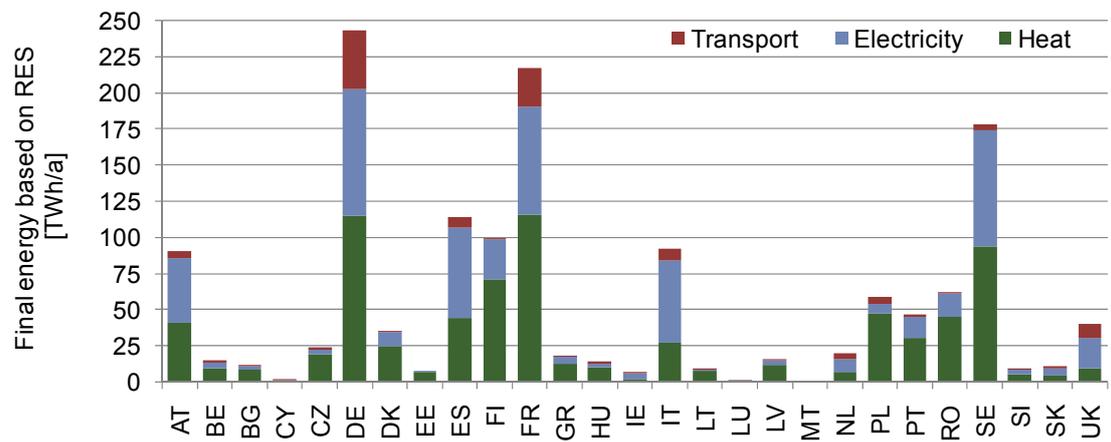


Figure 2-7: Final energy based on RES in 2008 (EU-27 member states)

Furthermore, we would like to take a closer look at the electricity and heat sector. In a first step, we show in Figure 2-8 the progress of EU-27 member states regarding the targets of the RES electricity Directive (2001/77/EC). As can be seen, a number of member states have already reached the target for the year 2010 in 2008 or are very close. Among these are Belgium, Germany, Denmark, Hungary, Ireland, Lithuania, the Netherlands, and Slovenia. For

some countries like Austria, France, and Latvia consumption grew faster than RES-E generation, so that the share of renewable electricity declined since the base year 1997.

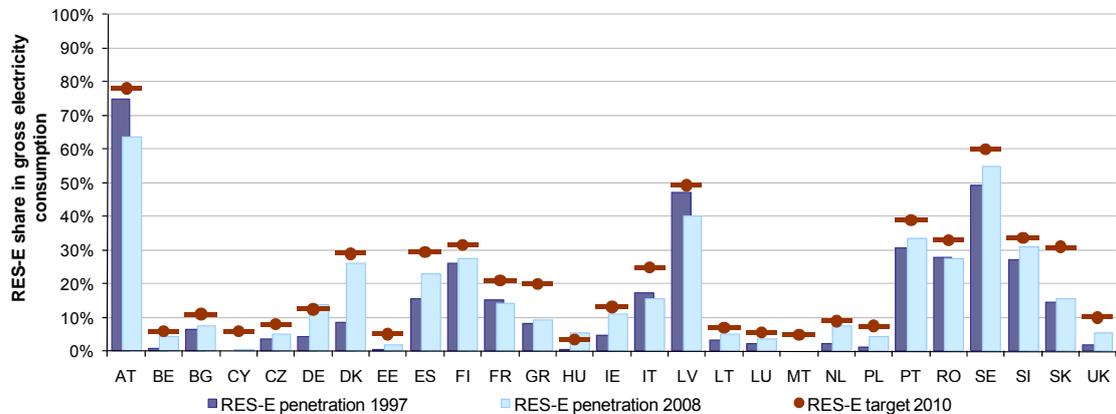


Figure 2-8: Progress of EU-27 member states regarding the targets of the RES electricity Directive (2001/77/EC)

In the following Figure 2-9, the contribution of RES-E technologies excluding hydropower is shown for the EU member states. Wind power on-shore shows the dominating contribution, followed by solid biomass and biogas. Of interest are (i) the large proportions of wind power in Denmark, Spain, and Germany, (ii) the significant contribution of geothermal power in Italy, and (iii) high proportion of power generated from biomass in the UK (including landfill gas, municipal waste and sewage gas), Finland, Sweden and Germany.

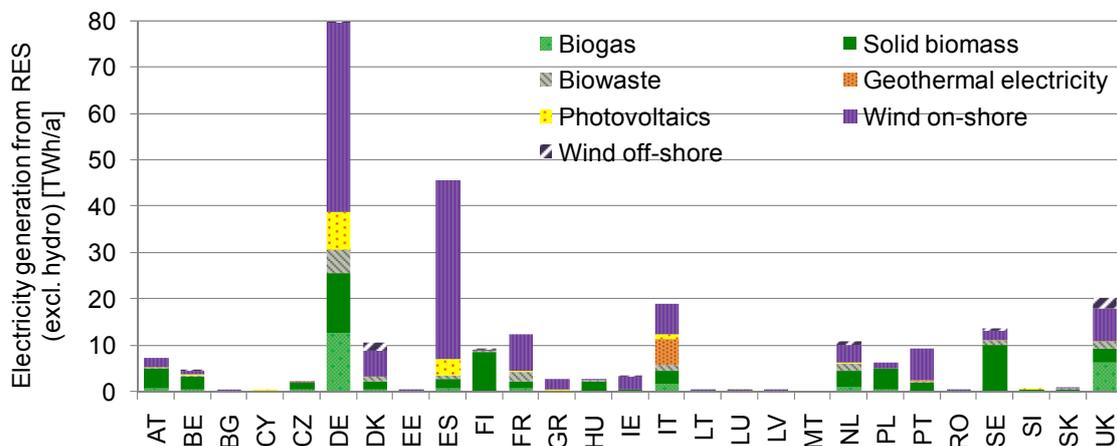


Figure 2-9: Electricity generation from RES-E technologies (excl. hydropower) in 2008 [TWh]

Finally, Figure 2-10 shows the contribution of RES-H technologies for the EU member states. Biomass in decentralized non-grid connected applications is still by far the dominant renewable energy source in the heating sector, followed by grid connected biomass. Solar thermal

applications show relevant contributions already in Austria, Cyprus, Germany, Spain and Greece. Heat pumps show a relatively strong development in Germany, France and Sweden.

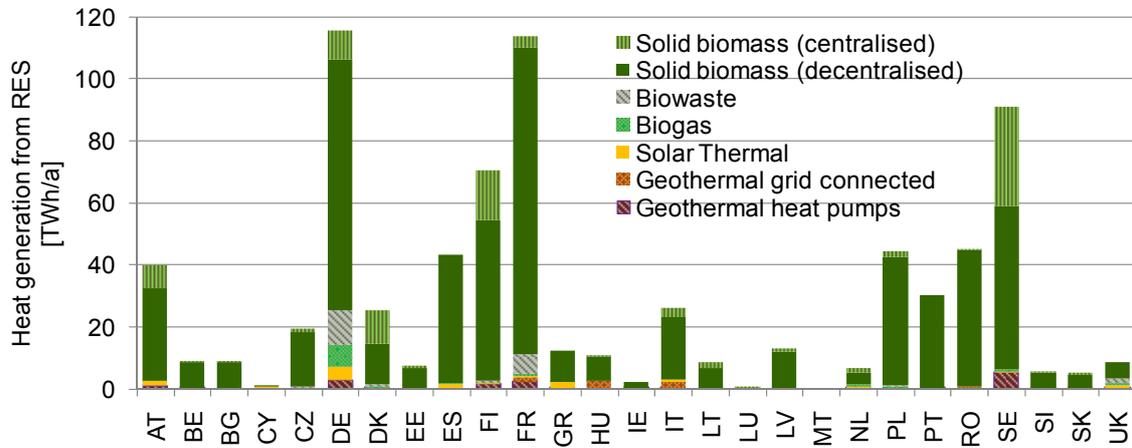


Figure 2-10: Heat generation from RES-H technologies in 2008 [TWh]

## 3 The RES Directive

In June 2009 the EU Directive on the promotion of the use of energy from renewable sources (2009/28/EC), subsequently named the RES Directive, entered into force. This Directive sets binding national targets for all EU member states to reach an overall renewable energy sources (RES) contribution of 20% in the EU's gross final energy consumption by 2020 and a 10% share of renewable energy specifically in the transport sector. Within this section, we provide a concise summary of the key elements, discuss the overall timeline for implementation and explore the role of the national renewable energy action plans.

### 3.1 The RES Directive at a glance

A non-comprehensive list of the key elements of the RES Directive, specifically recapitulated from the policy perspective, looks as follows.

- The overall target of achieving a share of 20% RES by 2020 refers to “gross final” energy consumption, which, in contrast to the commonly applied statistical definition of final energy, includes electricity and heat distribution and transmission losses, as well as own consumption of the energy branch.
- Following the RES Directive, the EU target is allocated to differentiated binding national targets based on a flat rate approach (same additional share for each country) modulated by the member state's GDP (per capita). The resulting RES targets are listed in Figure 3-1 which offers also a comparison with current RES shares (as of 2005). Additionally, this graph provides a graphic illustration of the domestic RES potentials as realisable in the 2020 timeframe according to the Green-X database.
- All three energy sectors are affected by RES: electricity, heating & cooling and transport. The decision on the mix of contributions from these sectors to reach their binding national targets is left to the member states. However, the RES Directive requires member states to develop detailed action plans that establish pathways for the future development of RES.
- Additionally, sufficient flexibility is intended to be ensured for member states to implement the Directive in the way that best suits their particular national circumstances. Consequently, member states are free to decide on appropriate domestic RES support, choosing the means that best suit their national circumstances. Moreover, as national targets are defined in a way that does not explicitly reflect the national resource availability (as can be seen in Figure 3-1), the RES Directive establishes cooperation mechanisms for member states, allowing them to fulfil their targets by supporting the development of renewable energy in other member states as well as third countries.
- According to the RES Directive, the minimum 10% share for renewable energies in transport is applicable to all member states. It has been set at the same level for each member state in order to ensure consistency in transport fuel specifications and availability, but it is expected that member states which do not have the relevant re-

sources to produce biofuels will be able to obtain renewable transport fuels from elsewhere.

- An accelerated biofuel deployment is seen - at the least from the European Commission's perspective - as an appropriate tool for tackling the oil dependency of the transport sector, which is one of the most serious issues affecting the security of energy supply that the EU faces at present. However, criticism was raised on the (non-) sustainability of an accelerated biofuel deployment, taking into account observable or expectable side effects (e.g. increasing food prices, land use changes and correspondingly low or even negative GHG savings for biofuels). Consequently, binding sustainability criteria on the use of biofuels were established by the RES Directive.
- The RES Directive also aims to remove non-economic barriers for an accelerated RES deployment - for example, by simplifying administrative procedures, by improving grid access and by fostering the development of infrastructural prerequisites for new RES projects.

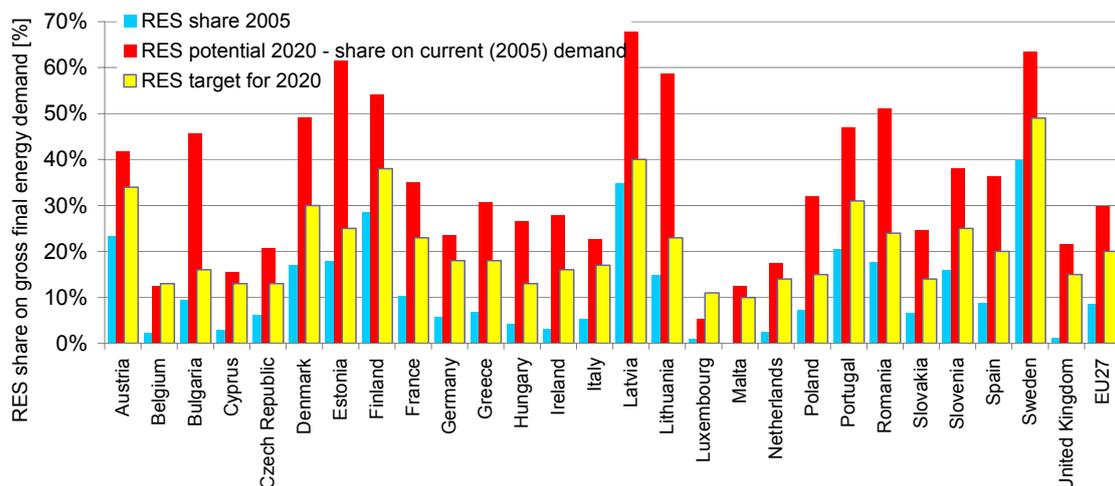


Figure 3-1: RES target for 2020 in terms of final energy demand compared to total national potential and already achieved RES share in 2005

Source: Green-X database - based on Resch et al. (2009)

### 3.2 Time line for implementation of the RES Directive

The RES Directive (2009/28/EC) as published on 23 April 2009 entered into force in June 2009. Thus, member states have been obliged to implement it into national law by December 2010 and consequently report this to the European Commission. In order to assure the practical further implementation and to monitor the progress achieved in the forthcoming years up to 2020, Article 4, 22 and 23 of the RES Directive specify in detail the subsequent reporting and monitoring obligations for member states as well as the European Commission. Key provisions as stated therein are summarized subsequently in Table 3-1 (next page). This table also contains other important milestones related to the implementation of the RES Directive.

In particular, member states were obliged to express in detail (following a given template) their view on achieving their RES commitment through national renewable energy action plans (NREAPs) by 30 June 2010, which are subject of a brief discussion in the subsequent section of this report. Later on, starting by 31 December 2011 and every two years thereafter, member states have to report the actual progress in achieving their expressed objectives. Furthermore, if actual progress would be below the indicative trajectory (as specified in the RES Directive), member states have to prepare a revised NREAP, including a clear expression of corrective measures, until June of the subsequent year.

Also, the European Commission has to meet a broad set of reporting requirements:

- Based on the national progress reports and their own complementary evaluation, a corresponding progress report needs to be provided from 2012 on periodically (every two years thereafter).
- Furthermore, the “report on requirements for a sustainability scheme for biomass” is expected to set important framework conditions for this sector.
- Special attention may be given to an evaluation report on the implementation of the RES Directive, notably with respect to the cooperation mechanisms, aiming to ensure that these mechanisms enable reaching the targets on the most cost-benefit basis, and the conclusions to be drawn to achieve the 2020 RES commitment. If appropriate, this report which is due by end of 2014 may contain a proposal of corrective actions.
- Later on, by 2018, the period beyond 2020 is subject of policy attention: The European Commission has to provide a report proposing a Renewable Energy Roadmap for the post-2020 period which may be accompanied by legislative proposals.
- Finally, in 2021 a report reviewing the application of the RES Directive shall be presented.

Table 3-1: Milestones and (selected) reporting obligations for member states and the European Commission as specified by the RES Directive

Date	Obliged party	Reporting obligation / Milestones for implementation
30 June 2009	EC ( <i>European Commission</i> )	Binding format for the national renewable energy action plans is made available.
31 December 2009	EC	Report on requirements for a sustainability scheme for biomass.
31 December 2009	MSs ( <i>Member States</i> )	<u>Forecast document</u> indicating the estimated excess production of RES compared to the indicative trajectory, the estimated potential for joint projects until 2020, the estimated demand to be satisfied by means other than domestic production until 2020
30 June 2010	MSs	<u>National renewable energy action plan (NREAP)</u> : The NREAP shall provide a detailed roadmap of how each member state expects to reach its legally binding 2020 target for the share of renewable energy in their final energy consumption.
<i>December 2010</i>	<i>MSs</i>	<ul style="list-style-type: none"> <li>• <i>Transpose the Directive's provisions into national law</i></li> <li>• <i>Communicate to the Commission how the Directive has been transposed into national law.</i></li> </ul>
31 December 2010	EC	Action plan on how to improve financing and coordination to achieve the 20% RES target
30 June 2011 – and every two years thereafter (2013, 2015, 2017, 2019)	MSs	Review and take necessary measures to improve the frameworks for bearing and sharing costs of technical adaptations to grids.
31 December 2011	EC	<ul style="list-style-type: none"> <li>• If appropriate: proposal permitting all RES-E to power all types of electric vehicles (including aviation, marine) to account for the target.</li> <li>• If appropriate: a proposal for a methodology calculating the contribution of hydrogen from RES in the fuel mix.</li> </ul>
31 December 2011 – and every two years thereafter (2013, 2015, 2017, 2019, 2021)	MSs	<u>Report on progress in reaching national objectives</u> (as expressed in the NREAP)
In 2012 – and every two years thereafter (2014, 2016, 2018, 2020, 2022)	EC	<u>Report on progress in reaching RES Directive objectives</u> (and may propose corrective actions).
<i>31 December 2012</i>	<i>MSs</i>	<i>Certification schemes or equivalent qualification schemes have to be available for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal systems and heat pumps.</i>
June 2013 - and every 2 years thereafter	MSs	MSs who are below the biannual milestones of the indicative trajectory have to submit an amended action plan
<i>31 December 2014</i>	<i>MSs</i>	<i>Member states shall, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in renovated buildings.</i>
31 December 2014		<u>Report on evaluation of implementation of the RES Directive, notably on the cooperation mechanisms to ensure that these mechanisms enable reaching the targets on the best cost-benefit basis, and the conclusions to be drawn to achieve the 2020 RES target.</u>
In 2018	EC	<u>Report proposing a Renewable Energy Roadmap for the post-2020 period.</u> It may be accompanied by legislative proposals
In 2021	EC	A final report reviewing the application of the RES Directive

### 3.3 National renewable energy action plans describing the member state's path towards 2020

Article 4 of the RES Directive requires member states to submit national renewable energy action plans by 30 June 2010. These plans, to be prepared in accordance with the template published by the Commission one year ahead, provide detailed roadmaps of how each member state expects to reach its legally binding 2020 target for the share of renewable energy in its domestic gross final energy consumption. Member states are required to set out the sectoral targets, the technology mix they expect to use, the trajectory they will follow and the measures and reforms they will undertake to overcome the barriers to developing RES. By January 2011, all 27 NREAPs were published (which seems quick, compared to the implementation of other EU legislations). These NREAPs have been briefly assessed in Klessmann et al. (2011), which also serves as main basis for the analysis presented in this section. According to the NREAPs, member states plan to over-achieve the overall 20% target by 0.6%. Whether or not the proposed actions will be ambitious enough to achieve these targets remains to be seen.

Considering that the RES growth in many member states was rather modest in the past years, these figures sound rather ambitious. Further analysis will be required to evaluate if the policy measures proposed in the NREAPs seem suitable to achieve this growth. From a first scan of 24 out of 27 NREAPs (all except Estonia, Hungary and Poland), this can be doubted, as the focus seems strongly on continuation and gradual adjustments of current policy, rather than on major improvements. However, some new policy measures are also proposed: at least eight member states want to introduce new policy schemes in the heat sector, including new RES-H obligations and feed-in premiums. The NREAPs also mention some new measures in the RES-E and RES-T sector, as well as for the removal of administrative barriers. The question remains, how these plans will be implemented in practice.

The NREAPs also provide information in which RES sectors and technology segments the projected RES growth is supposed to occur. In total, the RES share in electricity shall increase from 16.6% in 2008 to 34.5% in 2020, in heat from 11.9% to 21.4% and in transport from 3.4% to 10.3% (Eurostat 2010; NREAPs 2011, own calculations). Thus, the projected increase of the RES-E sector share (17.9%points 2008-20, corresponding to 1.49%points/a yearly average) is considerably higher than the increase of the RES-H share (8.8% points 2008-20, 0.73%points /a average) and the RES-T share (6.9%points 2008-20, 0.58%points/a average), which would mean a continuation of the higher growth of RES-E as compared to RES-H and RES-T observed in the past. Table 3-2 shows the absolute and relative contribution of the three RES sectors, as well as the projected sector growth. The total contribution of RES would be approx. 245 Mtoe final energy in 2020 (NREAPs 2011; Naegler 2011).

Table 3-2: NREAP projections by sector

Sector	Sector contribution (Mtoe)	Share in total RES consumption	Sector growth 2008-2020 (Mtoe)	Average required sector growth
RES-H	108	44%	40	3.9%/a
RES-E	105	43%	57	6.7%/a
RES-T	32	13%	22	10.2%/a

Source: Own calculations, based on NREAPs (2011), Naegler (2011)

The NREAPs project that wind power will be the dominant RES-E technology in 2020 - i.e. 40.6% of total RES-E generation shall be produced by wind power by then (Naegler 2011). According to the NREAP analysis of EREC (2011) and Beurskens and Hekkenberg (2010), wind on-shore will contribute the largest share, but more than 1/4<sup>th</sup> of the newly installed RES capacity is supposed to come from off-shore wind. Hydropower will contribute 30.4% of RES-E generation, followed by biomass electricity with 19.1% and PV with 8.5% (Naegler 2011). In the heat sector, 80.3% of all RES-H generation shall come from bioenergy (mainly solid biomass), complemented with heat pumps (11.4%) and small contributions of solar thermal (5.8%) and geothermal energy (2.5%). In transport, the dominating RES-T source remains bio-diesel. RES-E provides less than 10% of the RES transport energy, almost entirely in non-road transport (EREC 2011).

## 4 National policy implementation

### 4.1 Current investment dynamics

Investments in RES projects represent investments in tangible fixed assets and are financed by equity, debts and in some cases by grants. These three capital types differ with respect to their source and subordination. In general, subordinated capital shows a higher exposure to risks and hence requires a higher risk premium.

To analyze the current RES investment situation, the investments in RES projects are estimated via two approaches:

- RES investments are based on a dataset on financial activities (BNEF 2010) in the field of RE. The dataset provides information on the number and volume of transactions in the corresponding year.
- RES investments rely on the estimation of the monetary value of the installed RES capacities in the EU, based upon average capital costs per capacity (Held 2010) and capacities installed (EUROSTAT 2010). These investments reflect the capacities of the installations completed in the corresponding year.

Both approaches - the investment based on financial transactions and on capacity installations - are depicted in the following paragraphs.

#### 4.1.1 Investments in RES based on financial transactions

The database of BNEF applied in the first approach reflects asset financing related to the generation of electricity, heat or fuel from RES.<sup>1</sup> The estimation includes RES investments within the EU, differentiated into RES sectors, countries and types of transactions, such as acquisitions, refinancing or financing of RES projects by debts and equity. The financial transactions are marked with the status “announced” or “completed”. This status refers to the transaction status and not to the project development status. A completed or announced financing could coincide with different project development phases, e.g. project planning or construction, while refinancing or acquisitions can also take place during the operation phase. The analysis of the data refers to the number of transactions and the transaction volume. The transaction volume - if disclosed - either comprises total capital (equity and debt) invested, debt or equity only. Not disclosed values on transaction volumes have been supplemented.<sup>2</sup> Since the transaction volume only reflects partial investments - in several cases just equity or debt - total investments in RES tend to be underestimated. Furthermore, small individual

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1 Based on the output of the database of Bloomberg New Energy Finance, reflecting financial transactions.

2 Where deal values are not disclosed, an estimated value based on an average values per technology and per country is assigned.

investments, grants or investment subsidies provided by states, governmental organizations or NGOs are not listed in the dataset. However, this approach reveals current investment trends and activities, and allows a differentiation of investments with respect to financing instruments.

The results of the first approach show that asset financing of RES projects in the EU has significantly increased in number and transaction volume during the last decade. The number of planned, announced or completed transactions in RES projects encompassing biomass, solar energy, wind power, small hydropower, tidal power and geothermal plants reached the zenith with around 750 activities in 2008 and decreased slightly in 2009. Data on activities in 2010 are still incomplete and hence not fully usable. However, first publications of BNEF (2011) reveal even a further increase in RES investments in 2010. Regarding the type of transaction, financing of new RES installations dominates by number and volume and strongly determines the growth in RES financing activities.

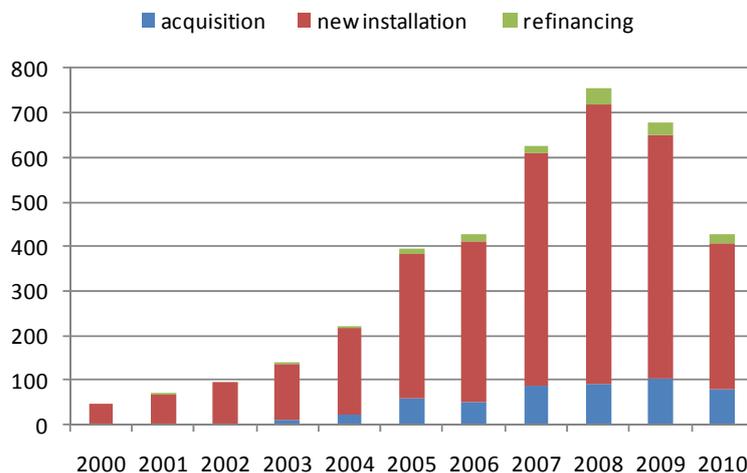


Figure 4-1: Overview of RES financing in the EU from 2000 - 2010, number of transactions

Source: Data based on BNEF (2011) - note that 2010 covers only a share of actual transactions

For further analysis, the completed transactions - and not announced or planned transactions - are of interest. The development pattern of completed transactions is similar to the pattern of total RES asset financing. In numbers and financed volume, investments peak in 2008 and 2009, respectively. The total volume of investments in RES projects in 2009 is estimated between € 20 and 53 billion. The range of uncertainty in the estimation based on the existing data is indicated in Figure 4-2. The large uncertainty is due to the fact that the total transaction volume is not disclosed for many projects in the database. The upper range refers to the assumption that the average transaction volume of all disclosed transactions is used for the non-disclosed ones. The lower range reflects the transaction volume if non-disclosed transactions are set to zero. In the last years, the investment in RES has been dominated by wind and solar power. Most of the transactions take place in Spain, the United Kingdom, Germany, France and Italy (2008 and 2009), where mainly PV and wind power projects are developed.

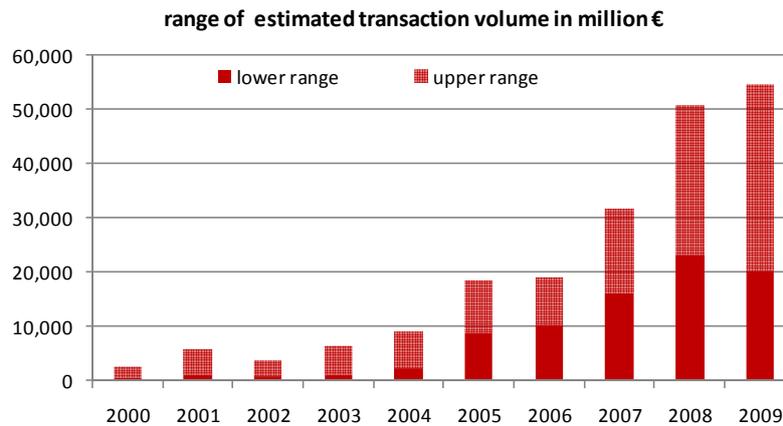


Figure 4-2: Financing of new RES projects in the EU from 2000 - 2009, estimated volume of transactions in million €

Source: Data based on BNEF (2010), adjusted for incomplete data; own calculations

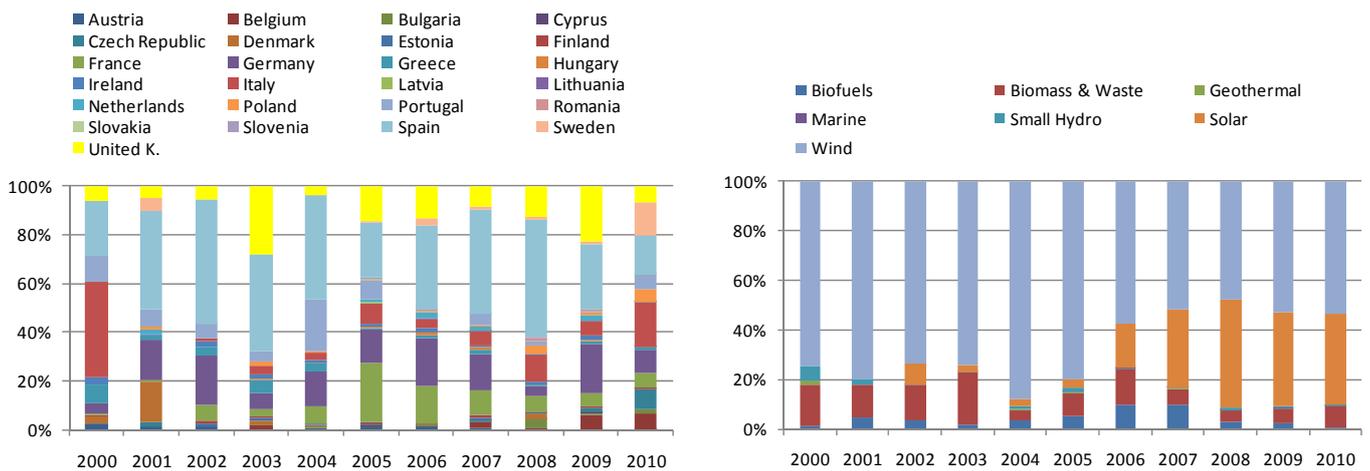


Figure 4-3: Share of financed new RES projects in the EU from 2000 - 2010 by country (left) and by RES sector (right), in %

Source: Data based on BNEF (2010), adjusted for incomplete data; exception 2010: representing a share of actual transactions; own calculations

Regarding the type of finance, balance sheet financing<sup>3</sup> is still dominating the financial activities, but with decreasing importance. In turn, loans - construction loans, syndicated bank loans - gain in importance. The growth of loans and public capital in RES financing signals an

3 Asset financing with equity and debt.

increasingly maturing market and decreasing risks, both also probably influenced by the increasing use of RES policy support mechanisms with guaranteed off-take prices.

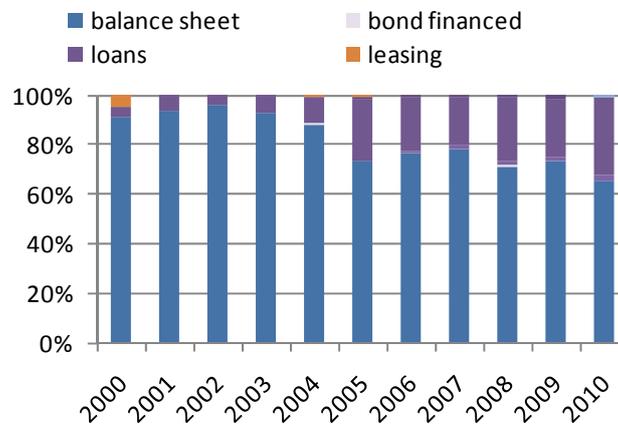


Figure 4-4: Shares of financing instruments, based on number of transactions (new installations), EU 2000 - 2010, in %

Source: Data based on BNEF (2010), adjusted for incomplete data; exception 2010: representing a share of actual transactions; own calculations

#### 4.1.2 Investments based on RES installations

A second approach, based on installations in RES power generation plants, was pursued. The investments are estimated based on the growth of installed RES generation capacities weighted with the average investment per capacity. The data on capacity installations relies on statistical data from EUROSTAT, where current data for 2010 or 2009 is not available yet. Therefore, the values<sup>4</sup> for 2009 are projected and not based on statistics about actual installations, as in the preceding years. The data for the average capital costs per installed capacity is applied as gathered in Held (2010). The investments enter the statistical database in the year the generation plant starts operation.

The results depicted in Figure 4-5 show a steadily increasing investment in RES projects reaching around € 40 billion in 2009. Regarding RES installations with respect to RES technology and country, PV and wind power have dominated the RES projects in recent years, and Spain, Germany, Italy, the United Kingdom and France are also the leading countries in RES investments. Compared to the first approach, this method reveals an investment volume that is significantly lower than the estimated investment volume based on financial transactions. Furthermore, it allows no conclusions on the financial instruments used to finance RES investments to be drawn, but it shows the capital funds needed.

<sup>4</sup> For biomass, hydro and solarthermal power, while data on installations in wind power and PV are available for 2009.

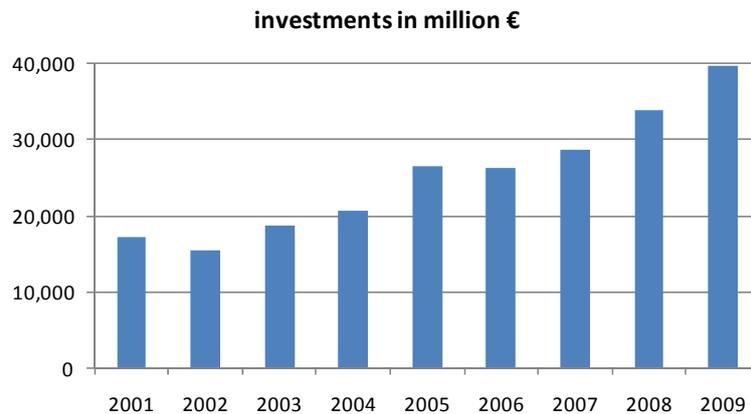


Figure 4-5: Investments of new RES projects in the EU from 2001 - 2009, in million €

Source: EUROSTAT (2010), Held (2010), own calculations and adjustments

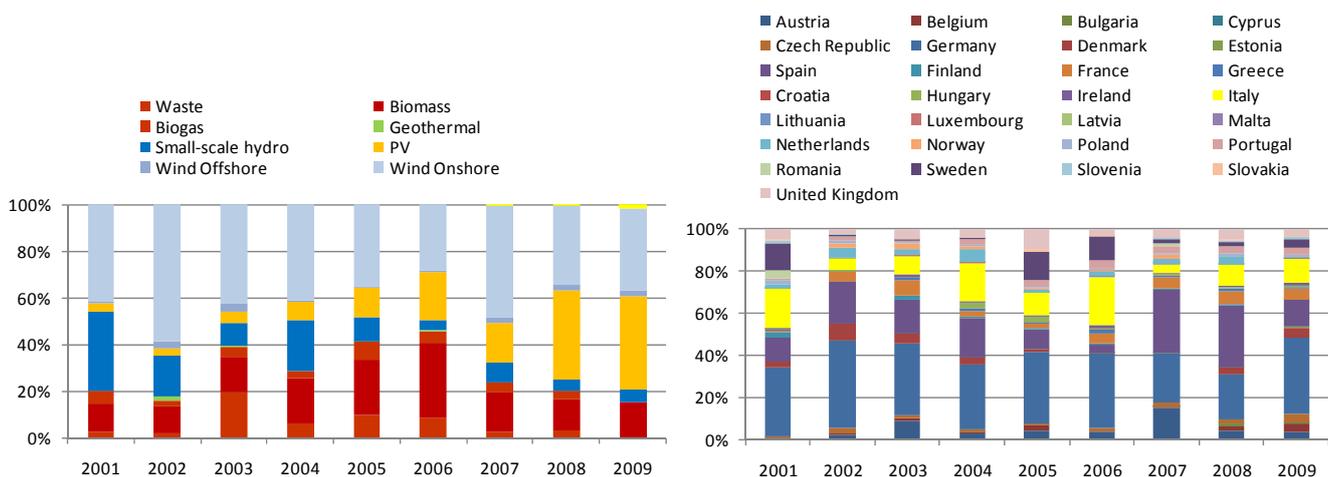


Figure 4-6: RES investments 2001 - 2009 in the EU by technology (left) and by country (right), in %

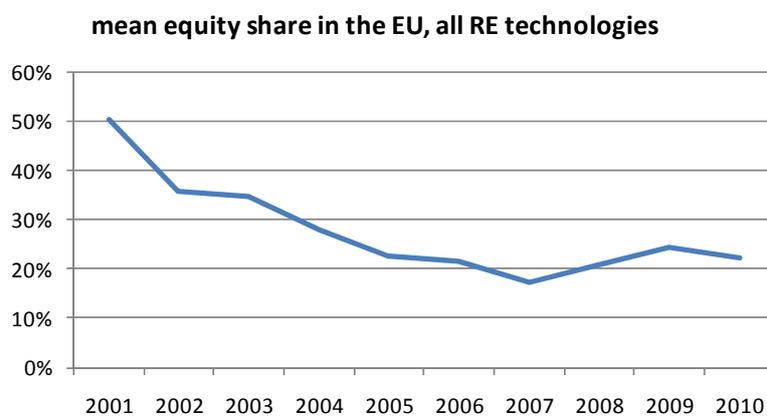
Source: EUROSTAT (2010), Held (2010), own calculations and adjustments

### 4.1.3 Conclusions

The estimated investments based on financial transactions show a similar level to those based on capacity of around € 40 billion in 2009, whereas the estimate based on completed transactions is subject to substantial uncertainty. In both approaches, most investments were carried out in wind power and PV and take predominant place in the same five countries, but with a slightly different order. One of the main reasons for the differences in investment volume is likely to be the time gap between financial transactions and installed capacity. The first takes place during planning, development and construction of the generation plant, while the latter occurs with the completed installation or operation of the plant. Further, financial

transactions include all RES projects (power and fuel, possibly heat) while installed capacities include only plants for electric power generation, but no fuel refineries. Additionally, data on financial transactions are most likely rather incomplete for the earlier years of the last decade. And finally, in 2000, markets for RES investments were less mature than in 2010, therefore probably less financing deals were concluded in the market.

The decreasing equity share in RES investments (see Figure 4-7) shows changes in financing patterns that could be explained by technology and market development, resulting in a reduction of risks. Furthermore, from the viewpoint of investors and lenders, the strong political commitment for RES might also contribute to a reduction and/or shift of risks.



**Figure 4-7: Average equity-debt ratio of RES investments in the EU from 2001 - 2010**

*Source: data based on BNEF (2010), based on a limited set of data, adjusted for incomplete data. Transactions with 100% share of debt or equity are ignored.*

Overall, in the EU, financial transactions - and hence investments - in RES projects have strongly increased over the last years and range between € 55 and 62 bn (US\$ 60 and 70 billion in 2008 and 2009, respectively). The estimated investments exceed those indicated by REN21 for Europe, the Middle East and Africa (US\$ 42 billion in 2009). Capital expenditures needed to achieve the EU deployment objectives are estimated at € 70 billion per year (Ecofys et al. 2011), which is still quite above the current actual investments; but they tend to get closer. Furthermore, capacity-based installation was relatively high at the beginning of the decade, but grew at a slower pace than financial transactions. The dominance of capacity-based investment in 2000-2006 can be explained by rather immature markets for RES investments, in line with a strong political commitment. While at the beginning of the decade balance sheet financing (with equity) strongly dominated the financial instruments, in recent years debts or loans are growing in number, revealing an increasing confidence of lenders and other investors in the RES business/market.

## 4.2 Survey of current support policies

It is the objective of this subchapter to assess the performance of member states in promoting RES technologies that has been achieved during recent years. Therefore, reliable evaluation criteria covering various aspects of renewable support policies have been defined and calculated. These aspects include the effectiveness of the policies - i.e. the achieved capacity growth of RES - and the economic dimension of policy support. Regarding the economic dimension, a comparison of the economic incentives provided for a certain RES technology and the average generation costs helps to monitor whether financial support levels are well suited to the actual support requirements of a technology. The analysis of non-economic barriers related to permission procedures or grid integration and connection, which may considerably influence the performance of support policies, are not part of this analysis.

### 4.2.1 Support measures for renewable energy

Depending on the final energy sector, different types of support measures have been applied in recent years. Most experience with supporting RES is available in the electricity sector, where the EU Directive 2001/77/EC required MS to increase the share of RES-E using national support instruments. In contrast, no legislative framework at EU level was available in the heating and cooling sector before the Directive 2009/28/EC was implemented. Support for renewable heating and cooling is mainly based on investment grants and partly tax exemptions. Although Directive 2009/28/EC obliges countries to use obligations for renewable heating, only some countries, including Germany, Portugal and Spain, have introduced obligations for a minimum share of renewables in the building sector so far. In the transport sector most MS use a combination of an obligation with tax exemptions.

Observing the evolution of the main support schemes in the electricity sector (compare Figure 4-8), it becomes clear that feed-in tariffs (FIT), feed-in premiums (FIP) and quota obligation systems and combinations of these dominate the applied support schemes. The latter is applied in Belgium, Italy, Sweden, the United Kingdom, Poland and Romania, often in combination with FIT for small-scale projects or specific technologies (BE, IT, UK). Thus, Belgium offers minimum tariffs for each technology as an alternative to the revenues from the TGC-trade and the electricity market price. Italy offers feed-in tariffs for small-scale applications below 1 MW and the United Kingdom started to make feed-in tariffs available for small-scale applications in spring 2010. Policy schemes such as tender schemes are not used anymore in any member state as dominating policy scheme, but they are used in certain MS for specific projects/technologies (e.g. wind off-shore in Denmark). Further policy measures such as production tax incentives and investment grants represent the dominating policy measure in Finland and in Malta. In some other countries, they are used as a kind of supplementary support, which contributes in some cases (e.g. tax incentives in the Netherlands) essentially to the economic viability of projects.

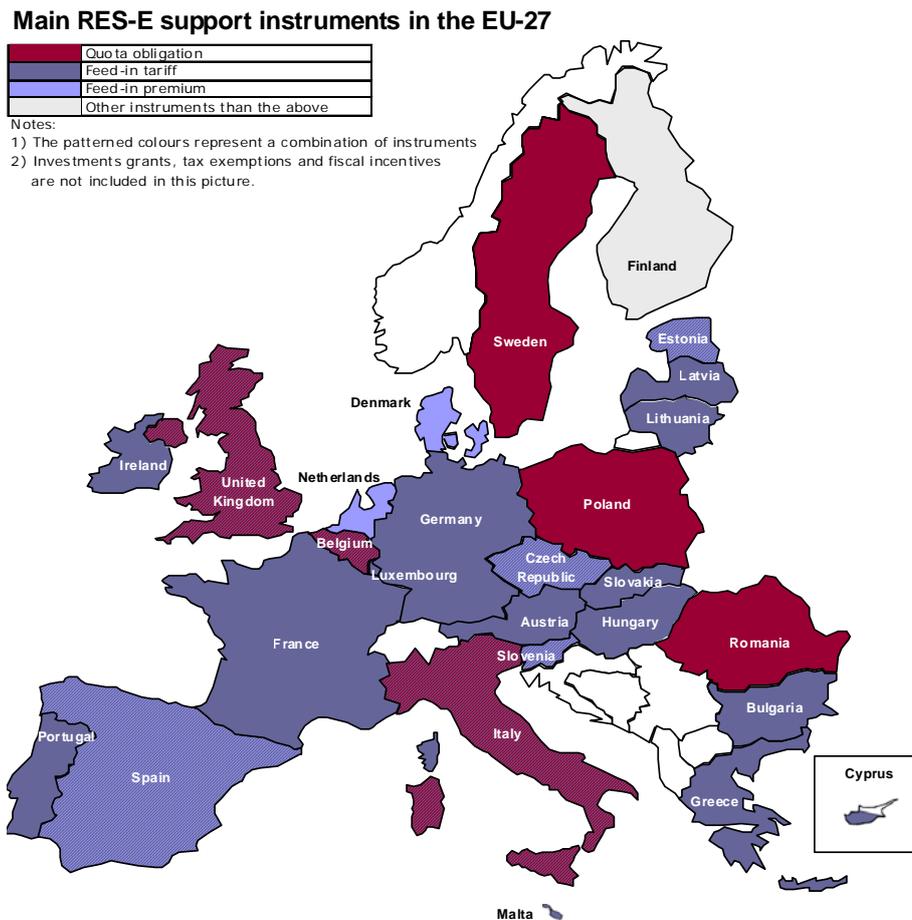


Figure 4-8: Main support instruments applied in EU27 member states

#### 4.2.2 Indicator-based analysis of the support scheme performance

In this section we assess the policy performance of the individual MS in recent years. The analysis is based on a set of quantitative indicators that has partly been used for many years and which was updated and extended within this project.

*The Policy Effectiveness Indicator* is calculated to evaluate the effectiveness of the support policies. Ragwitz et al. (2007) define the effectiveness indicator of a member state policy as the ratio of the change in the normalized final energy generation during a given period of time and the additional realisable mid-term potential until 2020 for a specific RES technology. The indicator does not evaluate the effectiveness of a single policy instrument, but of the overall RES policy mix for a specific technology applied in a country. Nevertheless, since all countries apply main support instruments that are considered dominant for their RES policy, such analysis also allows us to draw conclusions about these main support schemes. By reflecting the remaining achievable RES technology potential, the indicator accounts for the fact that RES potentials and consequently the achievable RES deployment differ between countries: member states need to develop specific RES technologies proportionately to the achievable potential to show comparable effectiveness of their support policies. Therefore,

the indicator is unbiased with regard to the available potentials of a specific country. The drawback of this indicator definition is its sensitivity to assumptions regarding the realizable potential. Furthermore, if the available potential is very low, the effectiveness indicator reaches very high values, even without substantial growth in RES deployment.

In order to explain potential differences in the policy effectiveness related to differences in the stage of deployment of a specific RES technology in a member state, we have developed the RES technology Deployment Status Indicator. The RES technology Deployment Status Indicator aims to measure the deployment status of RES-E and RES-H technologies in the EU-27 on a scale between immature and advanced. The indicator aggregates three sub-indicators that all express a different aspect of the RES deployment status:

- Production of RES technology as share in total sector (electricity/heat) consumption; this sub-indicator reflects the relevance of a technology for its energy sector and in how far it is visible for policymakers.
- Production as share of mid-term (2030) realizable potential; this sub-indicator reflects to what extent the mid-term potential for a specific RES technology is already being exploited, or, in other words, to what extent the potential that can be realistically developed until 2030 is already tapped.
- Installed capacity of RES technology; this sub-indicator serves as a minimum threshold and reflects whether a minimum capacity of this RES technology has been realized, in which case project developers, investors and banks have gained trust and experience in the national RES technology market.

*Economic incentives* resulting from the support of RES have been compared to energy conversion costs in order to evaluate whether the support level is well adjusted to the requirements of a technology. To make the remuneration level comparable, time series of the expected support payments or final energy prices, respectively, are created and the net present value is calculated. The net present value represents the current value of the overall support payments discounted. Finally, the annualized remuneration level is calculated, based on the net present value. *Electricity and heat generation costs*, levelised over the whole lifetime of the renewable power or heat generation plant are calculated and compared to the respective financial support level available. In this context, we also calculated the profit level range enabled by the support schemes and show it in combination with the policy effectiveness. A profit level of zero implies that an average return on equity is achieved, whilst positive profits lead to improved internal project returns.

The detailed methodology for the calculation of the indicators is described in Held et al. (2010). The subsequent section shows the results of the indicator-based assessment using the example of on-shore wind power plants. For results regarding the other renewable technologies the reader is referred to Held et al. (2010).

#### 4.2.2.1 Illustration of indicator set using the example of on-shore wind

##### Policy effectiveness

Figure 4-9 displays the *Policy Effectiveness Indicator* for wind on-shore power plants. The columns depict the average indicator of the observation period 2003 to 2009. In order to obtain an idea of the current trends of the policy effectiveness, the effectiveness indicator is also shown for 2009, the last year where statistical data is available. The colour of the columns indicates the policy instrument prevalingly applied in the respective country to support wind on-shore power plants. The countries are presented in the order of their deployment status (immature, intermediate, advanced, see next section).

Observing Figure 4-9, it becomes evident that the countries with the highest average effectiveness during the last seven years (Germany, Spain, Portugal and Ireland) apply feed-in tariffs to promote electricity produced by wind power plants (on-shore). Whilst Germany and Spain already effectively supported wind on-shore electricity before 2003, the wind on-shore development in Ireland and Portugal caught up after 2004. Regarding Ireland, the change from the tendering system to a feed-in tariff which took place in 2006 helped to speed up the development of wind on-shore energy.

The trend of policy effectiveness in 2009 observed in a group of countries with a reasonable average policy effectiveness including Belgium, Estonia, Hungary, Italy, Sweden and the UK is clearly upward. Despite existing grid capacity problems in Estonia, wind on-shore capacity increased from 77 MW to 150 MW in 2009. The accelerated growth in 2009 appears to be a result of the government's decision to increase the cap for electricity from wind power plants that receive feed-in tariff support from 400 GWh to 500 GWh. Although the grid capacity still appears to be a limiting factor in Italy, wind power plants experienced strong growth in Italy during the last five years. To tackle the grid-integration problems occurring in certain periods of the year Italy already implemented the rule of obliged curtailment of wind power. The example of Hungary - that showed the third-highest policy effectiveness in 2009, while it has the 15<sup>th</sup> rank in deployment status - shows that strong growth can be achieved also in member states starting from a low deployment level.

Looking at the situation in France, the effectiveness of policy support has been improving in recent years. However, given the vast wind energy potential, more growth than the additionally installed 1 GW of wind turbines in 2009 could be expected. Despite a favourable feed-in tariff system, problems with permission procedures and an active anti-wind lobby are still obstacles to higher growth rates.

Policy effectiveness in the Netherlands appears to be at a reasonable level on average. The capacity growth achieved in 2009 is mainly due to the repowering of old turbines. In the Czech Republic a reasonable capacity growth of wind on-shore power plants is hampered by a very strong growth of solar PV power plants. The extraordinary growth of solar PV in the Czech Republic may have involved some difficulties for wind projects to get permission to connect to the electricity grid.

Comparing the policy effectiveness of wind on-shore electricity with previous analysis (European Commission 2005; European Commission 2008), it becomes clear that countries using obligatory quotas such as Italy, Sweden and the United Kingdom have caught up in terms of policy effectiveness, in particular in 2009. However, their performance still lags behind policy effectiveness in the group of effective feed-in tariff countries Spain, Germany, Portugal and Ireland.

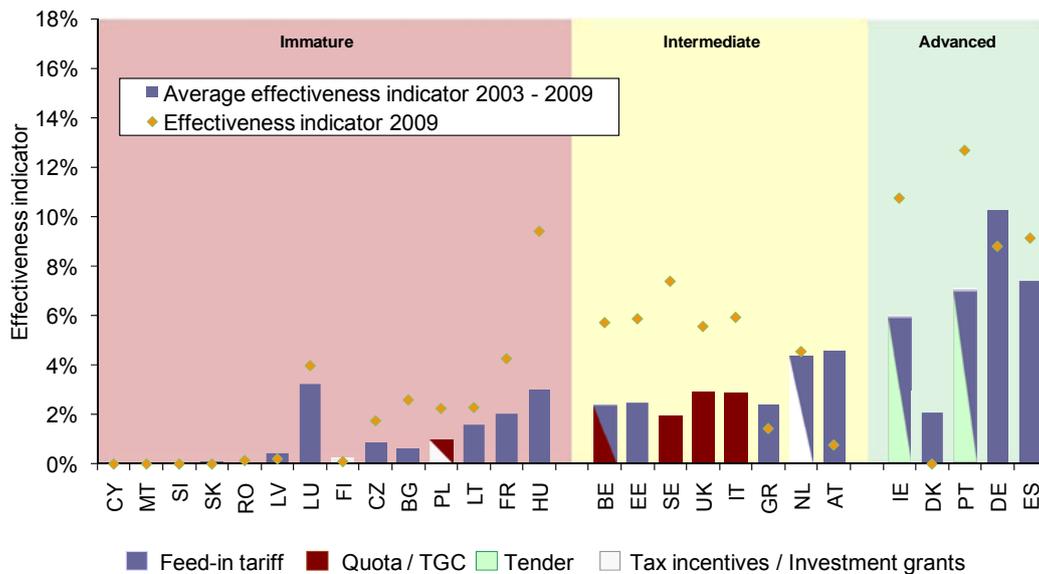


Figure 4-9: Policy Effectiveness Indicator for wind on-shore power plants in the period 2003 - 2009. Countries are sorted according to deployment status indicator

### Deployment status

Wind on-shore is one of the more advanced technologies (see Figure 4-10). The majority of MS meets (or exceeds) the 100 MW installation threshold. 15 MS reach the deployment status intermediate or higher. The results for the five advanced countries illustrate how the sub-indicators balance each other. The absolute market size and the share of exploited potential is in the medium range for Portugal, Denmark and Ireland (all < 4 GW installed capacity, 25-32% exploited potential), but wind energy already plays an advanced role in their electricity sector (10 or more percent of sector consumption). Germany has developed the largest wind on-shore market and exploited 57% of its on-shore potential, but the contribution to the electricity sector is at 6% not as high as in the other frontrunner countries. Spain is the only country that scores high on all sub-indicators.

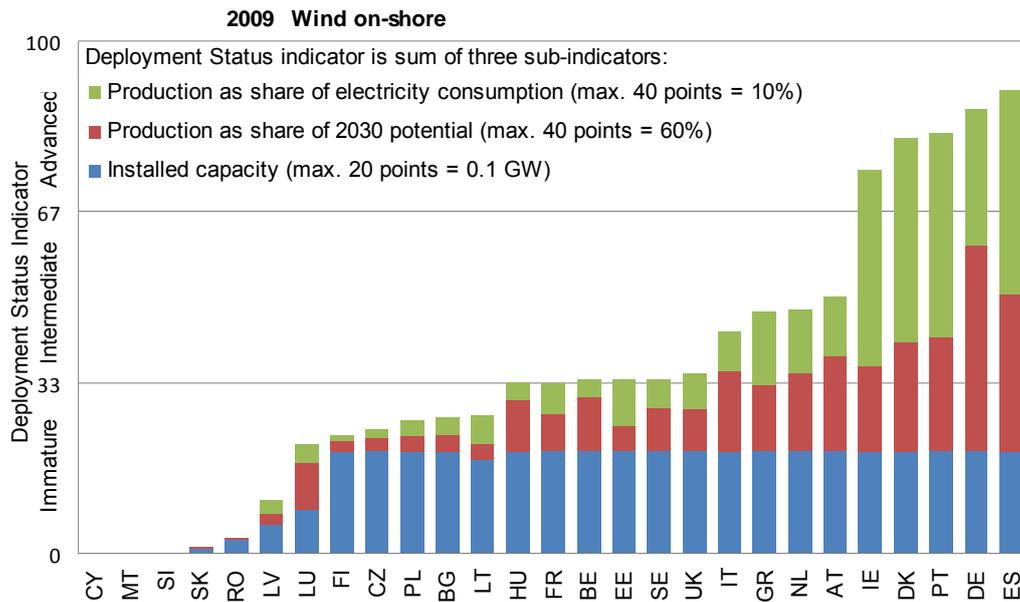


Figure 4-10: Deployment Status Indicator for wind on-shore power plants in 2009

### Economic incentives and generation costs

Figure 4-11 shows the range for the support level paid for electricity generated by wind on-shore power plants and compares it with the minimum to average electricity generation costs. Electricity generation costs of wind on-shore power plants increased during the last few years as a result of increasing steel prices and a strong demand for wind turbines. In general, almost all EU member states appear to provide a sufficiently high support level for wind on-shore electricity. Only in Austria and Luxemburg is the support level just high enough to cover the lower limit of electricity generation costs. In contrast, countries applying a quota obligation with tradable green certificates such as Belgium, Italy, Poland, Romania and the UK provide a support level which clearly exceeds the average level of generation costs. Likewise, the feed-in tariff in Cyprus leads to a rather high support level of roughly 166 €/MWh at the maximum. The system services costs are displayed in the figure. They notably contribute to the generation costs in Denmark, Spain and the Netherlands<sup>5</sup>.

<sup>5</sup> The system services costs are comprised of grid extension/reinforcement costs and balancing costs based on Weissensteiner et al. (2009).

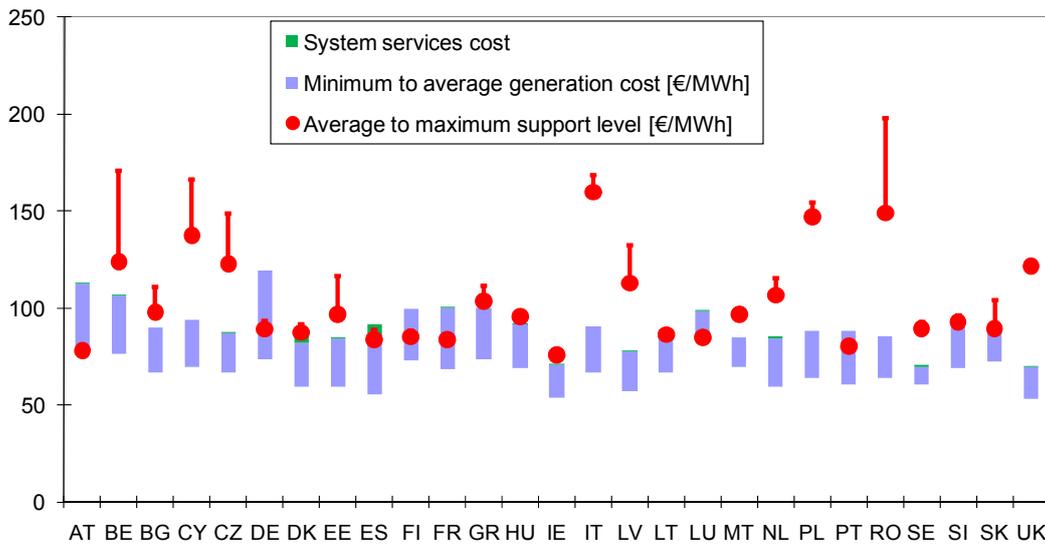


Figure 4-11: Support level ranges (average to maximum support) for wind on-shore in the EU-27 MS in 2009 (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs)

Profitability of renewable investments in relation to the policy effectiveness

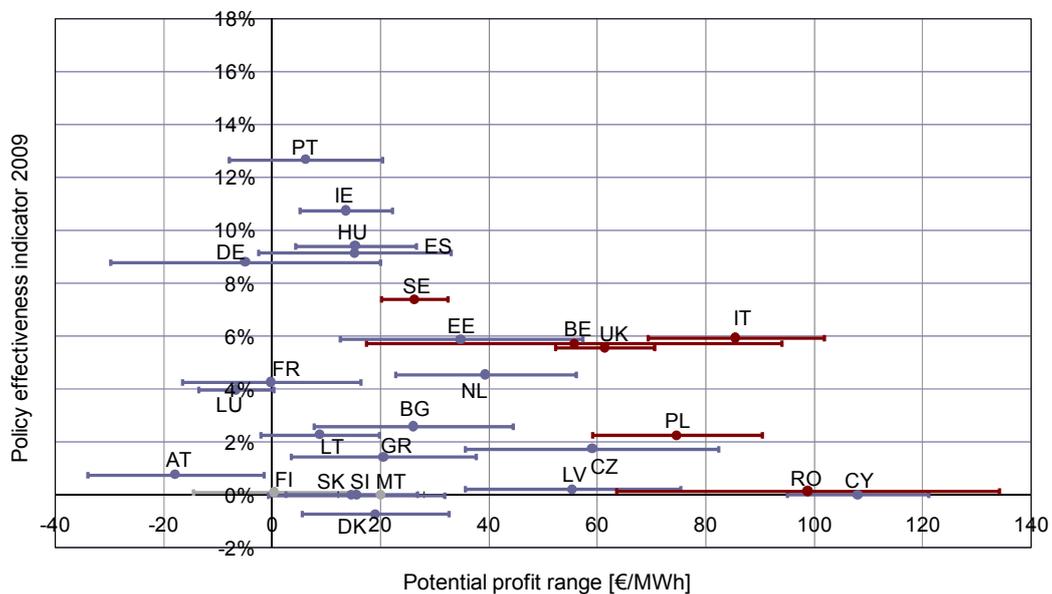


Figure 4-12: Potential profit ranges (Average to maximum support and minimum to average generation costs) available for investors and policy effectiveness indicator for wind on-shore in 2009 (A profit level of zero on the y-axis implies that an average return on equity is achieved, whilst positive profit levels imply improved internal project returns)

The combined illustration of the expected profit from an investment in wind on-shore power plants and the policy effectiveness indicator (see Figure 4-12) shows that, in general, the countries using feed-in systems such as Portugal, Ireland, Spain and Germany have achieved a rather high policy effectiveness at reasonable profits in 2009. The effectiveness of countries supporting wind on-shore power plants with a quota obligation including Sweden, Belgium, the United Kingdom and Italy, has improved clearly, comparing the year 2009 with previous years, and ranges between roughly 6 and 8%. However, it seems that the quota system still enables considerably higher profits for wind on-shore electricity compared to most of the countries applying feed-in systems involving windfall profits for investors. In some new member states as Poland, Romania, the Czech Republic, Latvia and Cyprus, we observe a very low effectiveness despite high potential profit opportunities. The Austrian feed-in tariff apparently is too low to stimulate further investments in wind on-shore power plants.

#### 4.2.2.2 Key messages from the policy performance analysis

In general, the support policy performance is rather heterogeneous, depending on the final energy sector, the RES technologies and the individual member state. The main messages from the analysis of the policy performance achieved in all EU MS in recent years in RES-E as well as RES-H technologies are as follows

##### Relationship between support level and generation costs

- If support levels are below generation costs, little or no capacity growth can be observed. There can be exceptions when investments are motivated by other than economic reasons (e.g. ecologic benefits or societal status). High support levels compared to generation costs do not in all cases lead to substantial capacity growth. Usually this is due to flaws in the support instrument, high risks involved for investors in certain markets or non-economic barriers in other parts of the regulatory framework (permission procedures, grid connection, electricity market structure, etc.). Too high support levels can also lead to unnecessarily high support costs.

##### Relationship between market deployment status and policy effectiveness

- Often a correlation between deployment status and policy effectiveness can be observed: markets with a higher deployment status tend to grow faster. However, some examples can be found where markets with a low deployment status also grow very quickly, as e.g. observed for wind on-shore development in Hungary. If adequate policies are applied and non-economic barriers are removed, markets can grow quickly without having an extremely long track record in the past, partially by using spill-over effects from other markets. If the market development has already achieved a very advanced stage, the effectiveness may decrease due to saturation effects or reduced policy efforts (see e.g. wind on-shore in Denmark).

##### Comparison of support in the electricity and heat sector

- Support levels for renewable heat generally appear to provide less profit than the ones

provided in the electricity sector, despite the low generation costs of many RES-H technologies. On average, policy effectiveness in the heat sector is also lower than in the electricity sector.

- Policy effectiveness of promotion schemes in the electricity sector is comparatively high in several countries, in particular with regard to mature, but still evolving technologies, such as wind on-shore and biomass conversion. Owing to the existence of a legal framework and sectoral (indicative) targets since 2001, some RES-E technologies including wind on-shore have experienced considerable growth in several countries. Therefore, more experience is available for RES-support in the electricity sector than in the heat sector.

**The resulting policy recommendations are:**

- If a member state wishes to increase the capacity of a technology, support levels should be aligned with generation costs, based on realistic assumptions for specific investments and cost of capital in case of price-based support schemes such as feed-in systems. In quota systems, the remuneration level may also be adapted indirectly by changing the quota target or banding coefficients, although it is more challenging to meet a desired support level.
- The support level required depends strongly on the existing non-economic barriers to projects, the design of the support system, and the risk involved for investors. By reducing barriers, applying best practice support system design and reducing risk, support cost can be massively reduced. Removal of certain barriers is not only useful to reduce support costs, but is imperative to allow any new projects to be realized.
- Countries with immature or intermediate market deployment status of a certain technology could take advantage of experience gathered in other countries. Policy effectiveness can be rapidly increased if the example of best-practice countries in support policy design and organization of administrative processes is adopted. Countries will then be able to profit from spill-over effects from the internationally available project development expertise and technology supply chain.
- When differentiating support instruments and support levels, policymakers should ensure that a balance is found between, on the one hand, developing higher cost technologies (progressing on the learning curve) and, on the other hand, deploying low-cost technology potentials at an adequate speed. This compromise can be achieved more easily by applying technology-specific support.

Regarding the individual sectors of renewable final energy, the following detailed key messages have been derived from this analysis.

► *Renewable electricity (RES-E)*

Comparison of support scheme performance

- Compared to previous analyses, the policy effectiveness in quota-using countries in the last two years shows improving values for low-cost technologies (wind on-shore and biomass), but in general feed-in systems still appear to be more effective than quota obligations. It should be noted that in the same period, e.g. in the UK, quota system risk for investors has been reduced substantially – from an investment risk perspective, the system evolved in the direction of a less risky feed-in premium system.<sup>6</sup>

Relationship between market deployment status and support scheme

- Depending on the deployment status and the maturity of a technology, different support instruments may be more or less suited. For example, technology-uniform quota obligations appear to be more effective in stimulating more mature and less investment intensive technologies, such as biomass-based renewable power plants than in promoting less mature technologies such as solar PV. Many member states act accordingly and apply different support instruments for different technologies<sup>7</sup>. For example, very often a feed-in premium or a quota obligation for large-scale and/or mature technologies is combined with a feed-in tariff for small-scale and/or less mature technologies.

Support level comparison

- The analysis of the economic characteristics of RES-E support and electricity generation costs reveals that the remuneration granted under a FIT system tends to be lower for lower-cost technologies than under a quota obligation scheme. In contrast, the remuneration level based on electricity price and TGC price in case of technology-uniform quota obligation schemes is generally lower than under technology-specific support for expensive technologies. In most cases this support level is insufficient to provide incentives to invest in more cost-intensive technologies such as solar PV.
- To trigger additional growth of cost-intensive technologies which do not receive sufficient support from technology-uniform quota obligations, some countries offer additional incentives, such as technology-specific minimum prices or feed-in tariffs. For example, Belgium offers minimum prices for solar PV electricity, Italy uses an additional feed-in premium for Solar PV and the United Kingdom has introduced feed-in tariffs for small-scale applications with a capacity below 5 MW. Technology-banding within the quota, which is applied in the United Kingdom, can help to support cost-

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<sup>6</sup> In the UK Renewables Obligation ‘headroom’ has been introduced, reducing the revenue risk of extremely low certificate prices in case the quota is reached.

<sup>7</sup> See Figure 4-8 and Figure 2-1 on page 3.

intensive technologies like wind off-shore, but is less suitable for small-scale projects than feed-in tariffs.

#### *Relationship between potential profit and policy effectiveness*

- The results have shown that high potential profit opportunities do not necessarily lead to high policy effectiveness. In particular, in the case of less mature technologies such as wind off-shore, an economically attractive profit level - calculated with uniform risk premiums - appears to be insufficient to stimulate capacity growth. Uncertainties related to technological, financial and administrative factors still appear to hamper a faster growth of these technologies. Also, political uncertainties about the future development of the support scheme (e.g. price development of TGC prices) may involve higher risk premium requirements or reduced policy effectiveness.

#### *Policy costs*

- When evaluating the policy effectiveness of a support scheme, stimulated capacity growth also may develop faster than envisaged and thereby cause high policy costs. This appears to be a risk of technology-specific support. Thus the application of feed-in systems carries the risk of involving considerable policy costs for consumers, if the market for a cost-intensive technology is booming unexpectedly, as happened with the development of solar PV power plants in Spain, the Czech Republic in 2008/2009 or currently in Germany. This risk exists to a lesser extent also in quota systems with technology-specific banding or minimum prices. Countries are therefore currently adapting quantity regulations in feed-in systems.

#### *Identification of best practice countries*

The leading countries in terms of effectively supporting wind on-shore energy are Germany, Spain, Portugal and Ireland. At the same time, all these countries show an advanced market deployment status. Looking at the effectiveness of policy support for wind off-shore, it becomes clear that market development is just starting in a few countries (the United Kingdom, Ireland, the Netherlands and Denmark). Examples for an effective promotion of solar PV are Germany, the Czech Republic and Italy. In terms of supporting biomass-based electricity, some MS already have a very advanced deployment status. Of the others, Belgium and the Netherlands have achieved the most effective policy support in 2008. In case of biogas power plants, Austria, Germany and the United Kingdom still apply very effective support schemes.

**Resulting policy recommendations are:**

- The support instrument applied should be chosen individually, depending on the target technology and on the country-specific situation, e.g. in terms of RES potentials. It is recommended to differentiate support instruments according to technology maturity (e.g. rather mature wind on-shore or rather immature wind off-shore), project size (rather kW range, few MW, or several hundred MW), type of envisaged investor (utilities, new independent power producers, small-scale business, households or farmers), or lender.
- Feed-in systems for technologies which are characterized by rapid cost reduction require frequent tariff adjustment cycles and good coordination of tariff levels with other relevant markets, to avoid extreme financial burdens to electricity consumers and to sustain public acceptance of RES support. When adapting the support level frequently, these changes in the support level should not seriously threaten investment security. If the tariff adjustments are done based on (automatic) adjustment formulae (related to market growth) and at dates that are known to the market sufficiently long beforehand, this policy cost risk can be managed without negatively affecting the investment climate.
- The European Commission could oblige MS to be more transparent in their RES support. Thus it would be helpful to put information on (the assumptions for calculating) average support and profit levels directly from the member state governments on a transparency platform. This should help member states to determine (technology-specific) support levels in such a way that they suit their (technology-specific) deployment target and avoid boom-and-bust-cycles.

**► Renewable heat (RES-H)**Policy effectiveness and infrastructure

- The existence of district heating grids is crucial for the realization of renewable-based centralized heating systems. This means that, depending on the situation of the gas and district heat grid, no short-term structural changes are feasible. Similarly, the competition between gas and district heating grids may have an impact on the effectiveness of policy support for centralized biomass heating applications. For example, the expansion of the gas network in Greece in recent years appears to hamper a stronger development of district heating grids.

Technology-specific observations

- Long reinvestment cycles limit the diffusion rate for the integration of renewable heating systems that are integrated in buildings.

### Burden sharing

- The dependence on financial incentives - predominantly in terms of investment grants - on the public budget and a potential stop-and-go policy creates stronger uncertainty for investors in the heat sector than is common in the electricity sector, since RES-E support is mainly based on long-term commitments. For example, the German "Markt-anreizprogramm" (MAP) was suspended for budgetary reasons and was re-launched recently in summer 2010.

### Identification of best practice countries

- Austria, Denmark, Finland, Lithuania and Sweden have effectively promoted biomass-based centralized heating plants in recent years, with an ascending trend in 2008. Several factors, such as the existing infrastructure of district heating networks in northern European countries, the biomass availability and a sufficient heat demand certainly have an effect on the successful support of biomass-derived district heating and large-scale CHP-plants.
- In general, the support for decentralized biomass heating plants is higher than for centralized plants. According to our analysis, Belgium, the Czech Republic, Germany and Romania have shown the most effective support policies for decentralized biomass heating in terms of the policy effectiveness indicator.
- Owing to a high remaining resource potential, the policy effectiveness for the support of solar thermal heating is rather moderate. Austria, Greece and Cyprus rank among the group of leading countries in terms of effective support policy. In Austria, communication campaigns and investment incentives have primarily contributed to this positive market development.
- Ground-source heat pumps have been effectively promoted by using obligations in Sweden and investment grants and fiscal incentives Hungary and Finland. The transition to the use of heat pumps in Sweden was favoured by a previously high share of electric heating.

Regarding policy support in the heat sector, we recommend the following actions:

- It might be useful to consider whether the observed low profit levels in the heat sector need to be increased. This can be done also implicitly by implementing RES-H building obligations.
- Existing successful support instruments in the heat sector should be maintained, but should be based on a stable financing source and a stop-and-go policy should be avoided. Experiences in the RES-E sector show that instruments financed outside the state budget, for example, via surcharges on the heat (fuel) cost may considerably increase the stability of the support instrument.
- Due to the often long reinvestment cycles in the heat sector (e.g. due to building

structure, district heating grids), it might be useful to now already start supporting those technologies in particular that are likely needed in the future energy system. This might refer especially to technologies that are beneficial for system integration of fluctuating RES-E, like heat pumps or biomass CHP in combination with large heat storage, which can constantly adapt production and demand to the requirements of the overall power system, based on power price signals.

#### ► *Renewable transport (RES-T)*

- Despite the uniform European biofuel target, deployment varies significantly across member states.
- The support of biofuels in recent year is characterized by a comparatively high effectiveness. However, the development in one of the leading countries, Germany, started to decrease from 2008 onwards, due to the phasing out of the tax exemption and the low biodiesel quota.
- In general, a rather homogeneous level of support in terms of tax reduction among EU member states could be observed.

### 4.2.3 Support costs of renewable energy policies

The aim of this section is to give an estimate of the net support expenditures for RES-E technologies, i.e. the premium on top of the revenues from the conventional power market, at country level for the years 2007 to 2009. At first, we summarize the methodological approach that was applied, before presenting the results of this section.

#### 4.2.3.1 Approach

The approach chosen to estimate the support expenditures is based on a bottom-up calculation using statistics of annually installed capacities and total RES-E generation, and specific support expenditures per technology and country. In the case of operational support<sup>8</sup>, which represents the common practice with respect to financial incentives for RES-E in Europe, support expenditures are calculated based on information about the total amount of electricity generated in one year on technology level and the corresponding support level. Owing to the heterogeneity and the complexity of the national support schemes, it is rather challenging to estimate the support expenditures based on the information available. These circumstances apply in particular to the application of feed-in tariffs, as described below.

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<sup>8</sup> In the case of investment-focussed support, the calculation of support expenditures is typically more straightforward, as the amount of (net) support expenditures directly arises from the offered up-front support as determined commonly per unit of installed capacity and the corresponding plant size (i.e. the installed capacity).

Feed-in tariffs are partially more differentiated than the technology specification of the historic data available. For example, in the case of biomass, tariffs may be determined according to the type of feedstock used or to the size of the renewable power plant, whilst the statistical data only provides data on higher aggregation level. As a consequence, average values are taken for the calculation of the available support level.

Since in the case of feed-in tariffs different tariff levels may be paid, according to the initial year of operation of the corresponding renewable power plant, one should split up the technology-specific electricity generation according to the initial year of operation. It is also not always obvious if older plants, such as small-scale hydropower plants, still receive support for the electricity produced. In addition, older plants may still receive support from a support scheme that has already been substituted.

To estimate the support expenditures, we draw on data on the average support level for the years 2005, 2007 and 2009, which has been compiled in the context of several other research projects such as OPTRES, futures-E and Re-Shaping. These support levels have been multiplied by the amount of electricity generated in the respective technology in a certain year.

Thereby, the total electricity generation was split up according to its initial year of operation. This means that the annual additional electricity generation of one technology is assumed to correspond to the electricity output of the newly installed capacity. This amount is then multiplied by the support level available in the respective year. For renewable power plants that have been installed between 1990 and 2005, the 2005 support level is assumed, since no time series for the time horizon before 2005 are available. In case of small-scale hydropower, we assume that plants that have been built before 1990 do not receive any financial support any more. In a final step, total support payment calculated is reduced by the product of renewable electricity generation and the reference electricity price of the respective year.

Given the circumstances explained above, the calculation of the support expenditures realized in this section should be interpreted carefully, as they are only indicative values based on estimations. To get an idea about the quality of the estimations, the support expenditures are compared as examples to figures published by national governments. In this case, data on support expenditures published by Spain, Germany and the United Kingdom are compared with our estimations.

#### 4.2.3.2 Results

The results obtained from these bottom-up calculations are presented in Table 4-1. According to the estimation performed, the net support costs of the EU have increased from roughly € 9 billion in 2007 to € 16.9 billion in 2009. However, it should be noted that the estimates are indicative and may deviate from the real net support expenditures at national level. Looking at the year 2009, Germany appears to spend the largest amount for the support of RES-E, amounting to € 6 billion or to more than one third of total EU net support expenditures. According to these estimations, Spain spent € 3.8 billion, followed by Italy with € 2.5 billion.

Table 4-1: Results for estimation of net support costs<sup>9</sup>

	Estimated net support expenditures in 2007 [€ m]	Estimated net support expenditures in 2008 [€ m]	Estimated net support expenditures in 2009 [€ m]
Austria	361	384	454
Belgium	250	309	413
Bulgaria	3	4	18
Cyprus	1	2	2
Czech Republic	96	120	207
Germany	3,564	4,058	6,148
Denmark	152	150	142
Estonia	6	7	8
Spain	942	1,832	3,804
Finland	6	8	8
France	121	338	496
Greece	33	40	49
Hungary	52	60	82
Ireland	13	14	32
Italy	1,752	2,191	2,473
Lithuania	1	1	2
Luxembourg	13	15	17
Latvia	1	1	1
Malta	0	0	0
Netherlands	203	250	391
Poland	159	200	320
Portugal	104	130	195
Romania	10	10	11
Sweden	81	94	143
Slovenia	7	20	8
Slovakia	8	10	8
United Kingdom	1,061	1,159	1,435
<b>EU-27</b>	<b>9,001</b>	<b>11,408</b>	<b>16,867</b>

9 Net support expenditures (FIT or the sum of reference electricity price and green certificate price) are the total support payments reduced by the product of reference electricity price and the total amount of RES-E generation.

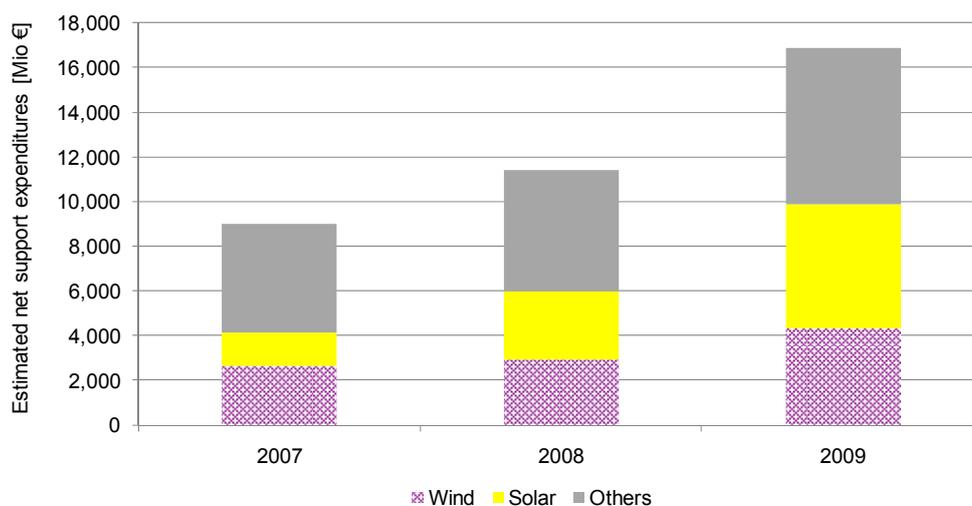


Figure 4-13: Technology-specific breakdown of net support expenditures for RES-E in the period 2007 to 2009 at EU level (based on bottom-up estimates)

Further insights on the composition of net support expenditures are given in Figure 4-13, indicating a technology-specific breakdown of expenditures for the period 2007 to 2009 at EU level. Remarkable is the increasing share of support expenditures for solar electricity, specifically due to the high growth of photovoltaics in several EU countries like Germany, Italy, Belgium and the Czech Republic.

Table 4-2: Exemplary comparison of support expenditures with data published at country-level for Germany, Spain and the United Kingdom

	Germany	Spain	United Kingdom
Estimated support expenditure in 2007 [€ m]	7,476	3,091	1,894
National support expenditure in 2007 [€ m]	7,879	3,370	1,690
<i>Difference of estimation to national data</i>	-5%	-8%	12%
Estimated support expenditure in 2008 [€ m]	8,051	4,609	2,118
National support expenditure in 2008 [€ m]	8,717	5,705	1,975
<i>Difference of estimation to national data</i>	-8%	-19%	7%
Estimated support expenditure in 2009 [€ m]	10,503	5,931	2,542
National support expenditure in 2009 [€ m]	9,982	6,589	n.a.
<i>Difference of estimation to national data</i>	5%	-10%	

Source: based on data from BDEW (2009); BDEW (2008a); BDEW (2008b); CNE (2009); Ofgem (2010)

For the comparison with data published at national level, we compare the total payments without subtracting the reference electricity price. In the Spanish case, remuneration paid

for cogeneration plants, which do not necessarily have to be based on RES, are excluded. There may be small deviations with regard to British data, since the accounting period for the quota system starts in spring and not in January, as assumed in our calculations. Table 4-2 shows that we estimated support expenditures in Germany to be slightly below real data, amounting to 8% less than stated by the TSOs. In Spain our estimations underestimate support payments by up to 25% in 2008, whilst our calculations for the United Kingdom show an over-estimation of up to 12%. Additional comparisons appear to be necessary in order to evaluate the quality of these bottom-up estimations.

### 4.3 Convergence of current policies

Policies for RES-E are currently evolving very quickly. In many instances it can be observed that feed-in systems and quota systems are refined by implementing best practices. Certain design elements of these two main support systems also hint at a gradual convergence of their key properties. Changes can be thereby observed, particularly regarding the following aspects:

- technology-specific character of support in quota systems
- guaranteed tariffs for small-scale installations and more expensive technologies complementing quota systems
- premium models in case of feed-in systems and
- quantity control in feed-in systems.

#### Technology specification of support:

The question, which support instruments are best suited to stimulate the desired growth in the sector of renewable energies cost-effectively, has been discussed intensively at both scientific and political levels. As one conclusion from this debate, strong evidence argues for the usage of a technology-specific support, no matter which scheme is applied. The importance of technology differentiation is backed up by empirical results (see, for example, Ragwitz et al. (2007) or International Energy Agency (2008)), as well as analyses of the structure of support schemes. This accounts for national support schemes as well as for a possible harmonisation at EU level. In past years FIT were seen as the only option to provide this technology-specific support, since a wide range of options exists to design the tariffs based on the generation costs of the different technologies (Klein et al. 2008). Conventional quota systems based on certificate trading did not allow additional support for technologies with higher generation costs, because TGC systems try to induce a competition between all technologies, based on the current generation costs. Conventional TGC schemes treat all RES-E technologies

equally<sup>10</sup>, which leads to an unfair competition between technologies at different stages of development (del Rio 2004).

This situation changed recently when Italy as the first country introduced a technology-specific TGC scheme (Law 244/2007). In the United Kingdom the Energy Bill 2008 also introduced a similar differentiation in technology bands, which will briefly be described in the box below. Both new support designs differentiate the number of certificates issued for generating electricity from RES by the technology generating it.

When assuming that a certain technology differentiation is important for a successful RES-E support system, technology banding currently seems to be the most elaborated and detailed approach for TGC systems. Feed-in systems typically offer technology-specific tariffs. This is the case for all EU member states offering feed-in tariffs, with very few exceptions, like Estonia.

#### Box: Banding approach in the UK RO system

The renewables obligation (RO) system in the UK was originally set up on a technology-neutral basis, whereby 1 RO-certificate (ROC) was issued for every 1 MWh of eligible renewable electricity. From April 2009, the RO has been 'banded'; the number of ROCs awarded per MWh is now dependent on the technology type. Support to emerging technologies has been 'banded-up' and support to established technologies has been 'banded down'. The following ROCs are earned for each MWh of RES-E generated:

- 0.25 ROCs/MWh for landfill gas<sup>11</sup>;
- 0.5 ROCs/MWh for co-firing of non-energy crop biomass (with a cap on the proportion of a supplier's obligation that can be met through co-firing), sewage gas;
- 1 ROC/MWh for on-shore wind, hydro-power, co-firing of energy crops, co-firing of biomass with CHP, energy from waste with CHP, geopressure, standard gasification and pyrolysis;
- 1.5 ROCs/MWh for offshore wind, dedicated regular biomass, co-firing of energy crops with CHP; and
- 2 ROCs/MWh for dedicated energy crops, dedicated energy crops with CHP, dedicated biomass with CHP, wave, tidal-stream, tidal impoundment <1GW (barrage and lagoon), advanced gasification and pyrolysis, anaerobic digestion, solar photovoltaic, geothermal, microgeneration (50kW or less) regardless of technology.

In the April 2009 budget, the government announced that it was temporarily increasing the banding for off-shore wind from 1.5 to 2 for projects that reach financial close between 23 April 2009 and 31 March 2010, and from 1.5 to 1.75 for projects that reach financial close between 1 April 2010 and 31 March 2011.

<sup>10</sup> A technology that is not competitive had to be supported by additional or different measures, such as investment grants or an alternative FIT, e.g. the FIT for PV in Italy, where other RES-E technologies are supported by a TGC system.

<sup>11</sup> Northern Ireland has not banded landfill gas, which remains at 1 ROC/MWh.

### Guaranteed tariffs for small-scale installations and more expensive technologies complementing quota systems

In order to stimulate a stronger growth of emerging technologies and small-scale installations by providing better access to low-cost financing, some countries using quota systems as the main support system have started to complement these by feed-in tariffs.

The UK has only recently, on 1 April 2010, introduced a feed-in tariff for projects with a maximum size of 5MW. Other plants are continuously supported through the Renewables Obligation (RO). Projects smaller than 50kW always receive support under the FIT; projects between 50kW and 5MW can choose between support under the RO or the FIT. There is no proposed cap on the annually available budget or volume of new installations in the FIT scheme. The tariff is expected to deliver a return on investment of 5-8% for well-sited installations. It consists of three elements:

- Generation tariff: a fixed payment from the electricity supplier for every kWh generated.
- Export tariff: a guaranteed price for any surplus electricity that is not used on site but exported to the grid, also paid by the electricity supplier. It has been set at 3p per kWh.
- In addition, with power generated on site, sites will need less from the national grid, so power bills will be lower.

In Italy, the 2008 Budget Law (244/2007), updated by law 99/2009, also introduced a 15 years feed-in tariff for RES-E plants with capacities below 1 MW as alternative to tradable green certificates (TGCs) and a coefficient for banding TGC according to technologies, which is expected to have a significant effect on the market.

The performance of these schemes will need to be evaluated. However, it can already be stated that a broader portfolio of RES systems and technologies will have the chance to enter the market based on these systems.

### Premium models in case of feed-in systems

As alternatives to the common implementation of feed-in systems as a fixed tariff, a number of EU member states have implemented a premium feed-in tariff that is paid on top of the electricity market price (the *premium tariff*). In the latter case, the development of the electricity price has an influence on the remuneration level under the premium option.

The premium option shows a higher compatibility with the liberalized electricity markets than fixed feed-in tariffs. It allows a higher demand orientation of renewable electricity generation and is therefore more appropriate for integrating large RES shares into an electricity system. This is especially true for flexible RES technologies that can adjust production to demand. For supply-driven RES like wind or PV, it is questionable whether benefits from exposure to market prices will outweigh increased cost and support levels due to higher risk - for supply-driven RES technologies, fixed feed-in tariffs may remain superior. Depending on the detailed design of the premium option, the risk for the RES-E producers may be larger,

which increases cost of capital and thus the required support. This is the case for a fixed premium, where the premium does not depend on the average electricity price at the power market. In case of the sliding premium (as implemented in the Netherlands), where the premium is a function of the average electricity price, the investment risk increases less if implemented properly (however, in the Netherlands investors are faced with a high risk of not being compensated for power market prices falling below a certain minimum level)<sup>12</sup>. Similarly, the most promising option to avoid extra costs for electricity consumers could be a premium varying with the electricity market price or a top limit for the overall remuneration paid in the case of the premium option. A bottom limit could be introduced as well, in order to compensate falling electricity prices. Such a cap and floor system has been introduced in Spain. Generally, it has to be said that premium feed-in design options are a very innovative instrument to combine all major advantages of feed-in systems with a higher demand orientation of RES generation and the need for a higher market compatibility of renewable generation. Currently, most of the European countries with feed-in systems opted for the fixed tariff model. Premium tariffs are applied in Spain, the Czech Republic, Slovenia, Estonia, the Netherlands, Denmark (for on-shore wind energy) and Italy (for PV).

#### Quantity control in feed-in systems

Many EU member states also want currently to support more expensive technologies with substantial future cost reduction potential, but are afraid that support costs may increase uncontrollably. Some countries set caps, limiting the number of annual installations to a certain capacity or financial amount. The downside of caps is the reduced investment stability for market parties and a frequent stop-and-go in the market. Therefore, other countries set growth corridors with continuous automatic adjustment of tariffs. The latter option preserves investment stability to a higher degree, but in order to be effective in limiting the increase of support expenditures, automatic adjustments may have to be frequent and/or rigorous.

A growth corridor or growth path is the amount of renewable capacity a country would like to see installed in a given year (e.g. 800-1,200 MW, or 1,000 MW) or part of a year (e.g. 200-300 MW per three months). In case growth is in line with that growth corridor, the normal tariff degression would apply (e.g. minus 10% per year). In case growth is stronger than envisaged, the tariff degression is increased (e.g. minus 1% per 10% overshoot). In case of less growth than envisaged, tariff degression is decreased. The higher the frequency of adjustments (e.g. once in three months instead of once a year) and the higher the increase of tariff degression in case of overshoot, the higher the control on support cost, but the lower the investment stability. Germany currently uses this system in the case of photovoltaics, whereas Spain applies a fixed cap for the annual installed capacity. Adjustments in Germany were not frequent/rigorous enough in the past, but more frequent/rigorous adjustments are currently under discussion. Ineffective quantity control often leads to unexpected policy changes when

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<sup>12</sup> Besides, in the Netherlands project development risks are considered to be high due to frequent policy changes in the past and an annual cap on the new installed capacity.

member states want to abruptly limit support cost. This causes stop-and-go policies and reduced investor confidence which may have repercussions for other member states. This could justify European Commission action: the EC could oblige member states to be more transparent in their RES-support. It could be helpful to put information on (the assumptions for calculating) average support and profit levels directly from the member state governments on a transparency platform. This should help member states to learn from each other and to determine (technology-specific) support levels in such a way that they suit their (technology-specific) deployment target and avoid boom-and-bust-cycles.

## 5 Next steps for RES support policies in the EU

### 5.1 Exploration of cooperation mechanisms

#### 5.1.1 The principle: Cooperation mechanisms for a cost-efficient target achievement

As stated previously, the RES Directive sets binding national targets for all EU member states to reach an overall renewable energy sources (RES) contribution of 20% in EU final energy consumption by 2020. These national 2020 RES targets are defined in a way that does not explicitly reflect the national resource availability. In order to allow for cross-border support of renewable energy in a most cost-efficient manner, articles 6 to 11 of the Directive introduce three cooperation mechanisms between member states: statistical transfer, joint projects, and joint support schemes as well as physical transfer from third countries. All three intra-EU mechanisms provide member states with an option to agree on cross-border support of RES. Thereby, one country can partly make use of the more cost-efficient RES potentials of another country. By joining forces, member states may explore potentials which otherwise would have remained untapped.

- Statistical transfer means that renewable energy which has been produced in one member state is virtually transferred to the RES statistics of another member state, counting towards the national RES target of that member state.
- Joint projects between member states are RES electricity or heating/cooling projects that are developed under framework conditions jointly set by two or more member states; the involved member states define which share of the energy production counts towards which member state's target.
- Joint projects can also be implemented between member states and third countries i.e. countries outside the EU. A precondition is that an amount of electricity that equals the electricity amount generated from renewable sources and subject to this joint project is physically imported into the EU.
- In the case of joint support schemes, member states combine (parts of) their RES support schemes. The Directive defines general accounting rules and framework conditions for using the flexible mechanisms, but leaves the design and practical implementation of the mechanisms to the member states.

Member states need to define the regulatory framework for using these cooperation mechanisms. Such a framework has to fulfil the set of conditions laid down in the RES Directive, but it also needs to reflect on legal aspects regarding the structure of all mechanisms, in order to ensure clarity, feasibility and the national energy policy aims.

## 5.1.2 The envisaged use of cooperation mechanisms - The case of Italy

Besides Sweden, which is aiming to establish a joint support scheme for RES-E together with Norway, Italy is one of the most prominent representatives that aims to use cooperation mechanisms proactively to meet its RES commitment.

The concept to use imported electricity to meet the 2020 target is more than a simple idea. In fact, investment projects are under way by several Italian companies (ENEL, A2A primarily) to exploit resources in third countries and import electricity through the new transmission infrastructures in construction in the Mediterranean basin. As a matter of fact, Italy already imports quite significant quantities of renewable electricity (some 35 TWh in 2010) from neighbouring countries (France, Austria, Slovenia, Switzerland), even if today it is not accounted for in the share of the final energy consumption according to Directive 2009/28/EC since it is not linked to any statistical transfer agreement.

According to the “Forecast Document”, indicating the “estimated demand for energy from renewable sources to be satisfied by means other than domestic production until 2020”, that each member state (MS) has submitted to the European Commission<sup>13</sup>, Italy would be the main user of the flexibility mechanisms foreseen by the Directive. In fact, it declared a deficit in internal RES production of around 1.2 Mtoe out of the 5.5 Mtoe stated by the 27 countries (i.e. 21% of the total)<sup>14</sup>. Italy declared that it will reach this target through the use of joint projects with third countries under Article 9 of the RES Directive specifically.

**Table 5-1: Import of energy by third countries (Italian NREAP)**

Third Country	Start of import	TWh from RES/year	Mtoe from RES/year	Reference period
Switzerland	*	4	0.34	1990-2000
Montenegro and Balkan States connected to the Montenegrin network	2016	6	0.51	1990-2008
Albania	2016	3	0.26	1998-2007
Tunisia	2018	0.6	0.05	
<b>TOTAL</b>		<b>13.6</b>	<b>1.16</b>	<b>1990-2007</b>

These estimates are deduced from the current projects of interconnection between Italy and the other countries submitted to the Ministry of Economic Development. In particular, the link with Montenegro received its final approval on 23<sup>rd</sup> of November 2010 with an agreement between the governments of the two countries and their transmission system operators (TSO).

<sup>13</sup> Art. 4 Directive 2009/28/EC

<sup>14</sup> European Commission, Summary Of The Member State Forecast Documents

On January 14<sup>th</sup>, 2011, Terna, the Italian TSO, issued the tender for the cable installation (2 x 1,000 MW, 500 kV direct current), to be completed by May 2013. The interest in the electricity sector of Montenegro is also witnessed by the fact that Terna owns 22% of the Montenegrin TSO CrnoGorski Elektroprenosni Sistem AD.

One of the main elements in developing such joint projects is to define the support scheme. In order to avoid double accounting, the Directive prohibits the third country from granting any form of support, other than investment aid. It is up to the MS to integrate this production into its national incentive scheme.

The Italian law<sup>15</sup> already allows the allocation of green certificates to the RES electricity imported from third countries that adopt instruments to promote RES similar to those applied in Italy (i.e. green certificates) and give them access to the electricity exported from Italy on the basis of a ministerial agreement, only when reciprocity is also possible (that Italian projects can obtain the certificates of the third country, even if the possibility of such convenience seems remote). Such an agreement has already been signed in 2006 with Albania and this led in 2009 to a partnership agreement between the Italian (AEEG) and Albanian (ERE) energy regulators with the aim of harmonising the regulatory framework.

Under the agreement, the green certificates could be allocated only to the actual production and to the quota of electricity which is object of an export contract and provided with a guarantee of origin. Table 5-2 reports the projects approved by the Albanian regulator (ERE), their planned capacity and expected production. As we can see, the annual generation could match the imports forecasted by the Italian NREAP, if all the electricity is exported (almost 3 TWh).

Table 5-2: Albanian projects qualified for green certificates

Type of plant	S/type	Installed Power (MW)	No of aggregates	Annual generation (GWh)	Status
HPP	basin	100	2	na	project
Wind farm	off-shore	500	250	na	project
TPP bio-mass	biomass	140	9	1,093	project
Wind farm	off-shore	234	78	750	project
Wind farm	off-shore	150	75	300	project
Wind farm	off-shore	150	75	330	project
Wind farm	off-shore	225	75	750	project
Wind farm	na	27.6	na	na	project
<b>TOTAL</b>		<b>1,526.6</b>		<b>3,223</b>	

Source: ERE (Albanian regulator)

<sup>15</sup> Art. 20 c. 4D.lgs 387/2003

In 2009, the Italian and Serbian governments signed an agreement to develop hydroelectric power in Serbia. This was followed, on June 2010, by the creation of a joint venture between an Italian company (SECI Energia) and Elektroprivreda Srbije in order to install up to 103 MW of hydroelectric power (with an expected annual generation of 450 GWh) to be exported to Italy through Montenegro. A further agreement to extend Italian green certificates also to Serbian renewable plants, like the Albanian one, is under discussion. Also, the discussion with North African countries is well under way and the interconnection under the Mediterranean Sea is among the projects funded by the European Union.

The effect of the foreseen RES generation abroad on the equilibrium of the Italian support system is not negligible, as 13 TWh would account for 25% of the target increase of RES production in 2020, according to the Italian NREAP.

As a matter of fact, the impact of this option on the Italian support system has not been duly studied. Considering the strong media campaign against the impact of RES support on the cost of electricity, supported by Confindustria, the union of the industry owners, further costs for investments outside Italy will meet strong opposition. RES policy, in fact, is mainly supported on the basis of domestic industrial benefits.

At present, Italy is still implementing the Directive 2009/28/EC and a far-reaching change of the green certificate system is being proposed, with the introduction of a tendering system for power plants above 5 MW and a feed-in system below (except for biomass where only FITs will apply). Considered the size of the projects abroad, the design of the tenders may be challenging.

## 5.2 Biomass trade and its implications for RES support

### 5.2.1 Overview of production and trade

Solid biomass use has grown over the past ten years. At a local level, woody and agricultural residues and wood chips are used for heat and power production, especially in regions and countries with large woody resources (such as Scandinavia and Austria), but increasingly also in other European countries. However, a number of countries (e.g. the Netherlands, Belgium and Italy) have limited resources of high-quality solid biomass, and have increasingly been importing biomass for power (the Netherlands and Belgium) and heat (Italy) production. This trade almost solely consists of wood pellets, although in some cases also wood chips, waste wood and firewood are traded for energy end-use<sup>16</sup> (Junginger et al. 2010).

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<sup>16</sup> These biomass types are typically traded more locally (e.g. only shorter distances, crossing only one border). Firewood is typically only used for heating purposes. Waste wood and wood chips are also used for electricity production. For large-scale electricity production / co-firing in coal power plants, it is expected that wood pellets will be the main biomass type to be utilized. We therefore focus solely on the wood pellet trade in the remainder of this section.

Approximately 670 pellet plants in Europe produced more than 10 million tonnes of pellets - an increase of about 1.8 million tonnes compared to an earlier study of production in 2008 (Sikkema et al. 2009). The largest producers are Sweden and Germany, producing about 1.6 million tonnes each. After Europe, North America is the largest wood pellet producer. Wood pellet production in the United States in 2009 amounted to 1.8 million tonnes, while for Canada, the production was 1.2 million tonnes (WPAC 2010). For an overview of global wood pellet production, see Table 6-1. Note that for many countries the actual production is often uncertain, as no production statistics exist, so these figures should be used with some caution.

**Table 5-3: Overview of global wood pellet production and trade flows within or towards the EU-27 in 2009**

	Production		Trade to / within EU-27	
	ktonne	PJ	Ktonne	PJ
EU-27 (production / intra- EU trade)	8,850	154.9	2,135	37.4
Other Europe <sup>1</sup>	1,350	23.6	637	11.1
United States	1,800	31.5	500	8.8
Canada	1,200	21	498	8.7
Rest of the world	192	3.4	77	1.3
<b>Total production</b>	<b>13,392</b>	<b>234.4</b>	<b>3,847</b>	<b>66.3</b>

<sup>1</sup> Including Belarus, Croatia, Bosnia and Herzegovina, Norway, the Russian Federation, Serbia and Ukraine

Source: Based on Eurostat (2010) for trade within and to EU-27

The demand for high-quality biomass, on the one hand, and availability of an excess of cheap feedstock for wood pellet production has triggered international wood pellet trade. For an overview of the current major trade flows, see Table 5-3. While some European markets (such as Germany or Austria) are largely self-sufficient, other markets depend to a very large extent on the import of wood pellets, like the Netherlands, Belgium, Denmark and Italy. On the other hand, in many producing countries (Canada being the prime example, but also other areas such as the Baltic countries and North West Russia), the pellet production sector largely depends on export opportunities. A rather new actor in the market is the USA, which started in 2008-2009 to export wood pellets from the South East via the harbours of Mobile (Alabama) and Panama (Florida). Hintz (2010) estimated about 500,000 tonnes of pellets are exported from the USA to Europe, which is twice the 2008 exports (UNECE 2009). The main trade routes are from North America to the Netherlands, Belgium and the UK, with average overseas shipments of 20,000 to 30,000 tonnes in Panamax freighters; and from the Baltic states and Russia to Scandinavia by coast liners with average loads from 4,000 to 6,000 tonnes (Selkimäki et al. 2010).

The wood pellet consumption for heating and electricity production in the EU-27 was estimated to be about 9.2 million tonnes in 2009<sup>17</sup>. As shown in Table 5-3, about 3.8 million tonnes (or more than 40%) of these pellets were traded internationally, either from one EU country to another, or imported from outside the EU.

### 5.2.2 Trade outlook and implications for flexibility

The global wood pellet production and trade has been increasing exponentially, and it is likely that strong further growth will occur in the next decade. The biggest growth areas in 2009-2010 were the South East of the USA and North West Russia, where currently wood pellet plants with capacities of 500-1000 ktonnes per year are being built. Also in other world regions, such as Latin America, Australia and southern Africa, wood pellet plants are being built, aiming primarily to export to Europe. However, this growth in supply will likely only occur if there is sufficient (European) demand. Estimates for the European pellet demand in various studies vary from 18 million tonnes in 2013, 16.5 million tonnes in 2015, 50 and 80 million tonnes in 2020 and about 28 million tonnes in 2025 (Sikkema et al. 2011). Most projections foresee the largest growth in the electricity sector, ranging from a modest 3% share for co-firing of pellets to even 20% co-firing shares in some utilities. While in theory, the EU could mobilize more of its own woody resources, in practice it is quite likely that imports from outside the EU will strongly increase in the future. Depending on the development of demand, and taking into account the current investments in production capacity, these could easily reach 5 to 10 million tonnes per year by 2020.

How much could such volumes contribute to renewable electricity production? As a rule of thumb, 1 million tonnes of wood pellets equals about 17.5 PJ primary energy, which (if co-fired in a modern coal power plant) is sufficient to produce about 2 TWh of renewable electricity. Assuming a moderate 5-10 million tonnes imports from outside the EU, which will be used almost solely for electricity production, between 10-and 20 TWh could be produced in the EU, based on imported biomass. In case the (very optimistic) 50 million tonnes EU consumption from the Aebiom scenario (Aebiom 2008) would be reached in 2020, probably more than half of this would have to be from sources outside the EU. In such a case, 30 million tonnes of wood pellets could in a best case allow up to 60 TWh of renewable electricity production. Assuming a price of 120 €/tonne (about 7 € /GJ) delivered to the end user (which is a typical price paid between 2007-2010 in the Rotterdam harbour), the electricity production costs are roughly 6 euro cent per kWh. This is solely based on the fuel costs, but additional investment costs in coal-fired power plants and O&M costs are relatively low. Also, the saved

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<sup>17</sup> Note that the total EU-27 production and imports by the EU-27 in 2009 do not match this consumption figure. This has several reasons: both production and consumption figures are estimated for a number of countries, as often no reliable statistics are available. Trade figures are monitored using Eurostat CN code 44.01.3020, which was introduced in January 2009. Significant discrepancies between recorded import and export volumes have been found. Finally, as significant wood pellet storage facilities exist in many EU countries, also stock changes may play an important role. Therefore, all numbers should be considered estimates. See Sikkema et al. (2011) for more details.

costs of avoided coal use and the value of CO<sub>2</sub> credits are not taken into account. The avoided costs of coal may be a significant factor determining the competitiveness of electricity from wood pellets – coal prices have varied between 2 and 4 €/GJ in past years. Thus, electricity production costs are likely to be competitive with e.g. electricity from wind farms with medium to high wind speeds, and well below production costs from e.g. a typical off-shore wind farm.

Which countries are likely to invest in large-scale electricity production from solid biomass? In past years, these have been Belgium, Denmark, the Netherlands, Hungary and the UK. In the future, also other countries with large coal-fired power plants (such as Germany, Poland, the Czech Republic and other eastern European countries) could cover significant shares of their RES-E target by co-firing (imported) solid biomass (Hansson 2009). Whether they will do this will depend largely on their other options to reach their RES-E targets.

Looking at the option of biomass trade from the perspective of the EU target achievement, as well as regarding the need for flexibility to reach the target, it is interesting to compare the different quantitative contributions. Based on the Green-X modelling, performed within this project, the total RES deployment needed to reach the target of 20% by 2020 amounts to about 2,980 TWh. The need for flexibility measures between member states is estimated at about 110 TWh by 2020. Therefore it can be seen that biomass trade from outside the EU leading to an electricity production of 20 TWh could substantially contribute to the need for flexibility, but may not be sufficient. Also, biomass trade within the EU can further add to the flexibility for target achievement, although one should discuss whether flexibility based on statistical transfers or physical trade of biomass are superior with respect to the overall environmental and economic balance.

### 5.3 The role of the EU for power market design

The EU power market design affects both the planning and operation of the power system. Hence it is essential to ensure that a suitable power market design is in place.

#### Congestion management

It will be essential that a market-based, uniform and efficient transmission capacity allocation mechanism is in place. The mechanism has to manage congestions both between and within countries, while avoiding the possible abuse of market power. European transmission system operators (TSOs) currently utilize a non-market based approach to congestion management within their country or control area.

The unlimited use of national transmission capacity is granted by system operators to all installations connected to the network. However, since capacity is a finite resource, generators are subsequently paid by system operators to reduce their use of transmission capacity when constraints occur. The resulting costs are wholly borne by transmission operators, in turn by the consumer, meaning the current market design is not only expensive and inefficient, but also creates perverse incentives to delay new generation connections and off-shore grid in-

vestment, e.g. by limiting efforts put into planning processes. In addition, the approach encourages generators to schedule an increase in output, so that they will then receive payment to reduce generation at the constrained location (also known as the increase-decrease or 'inc-dec game').

Because of the zonal nature of the existing power market design (outside Scandinavia), prices only change at national borders, even though most congestion occurs on lines within countries. Hence, with the wrong price signals, it is difficult to identify economic benefits and design an effective, common European grid infrastructure. Transparent price signals are particularly important for modular designs that need to demonstrate benefits at each stage.

### Incorporation of intermittency

Short-term balancing services need to be delivered across borders and have to be integrated with congestion management. Output from many renewables, particularly wind, is relatively uncertain in day-ahead forecasts, but improves towards high levels of accuracy four hours prior to real time. The maximum value of wind power can be realized if a flexible power market design fosters system-wide optimization across all actors in a short time-frame. For instance, Spain succeeded in keeping demand for balancing services constant, despite the large increase in wind deployment and the almost 'island' nature of the grid. If applied on a European scale, such a platform would have to be fully integrated with congestion management.

In an assessment by the European regulator's group for electricity (ERGEG), a nodal pricing approach was considered the "ultimate goal and (technically and economically) optimal solution", but only adjustments to the current power market design were subsequently proposed for consultation. The experience in several deregulated power and gas markets show that designs that do not appropriately address transmission constraints, or do not offer a consistent approach for integrating day-ahead and real-time energy trading, can be subject to market failures, including gaming and blackouts. This introduces significant on-shore and off-shore regulatory uncertainty that potentially undermines investment and innovation, since future changes to regulations can be expected, but neither their timing nor exact nature is clear to market participants. Thus, the early adoption of a robust power market design that is compatible with large-scale renewable deployment is necessary, and requires committed effort with a long-term perspective.

## 5.4 Attracting sufficient investments while limiting policy cost

Existing RES policies attracted annual investments into RES assets of about € 40 bn in the EU in the last years. Yet, capital expenditure needed to achieve the 2020 targets is about € 70 bn per year until 2020. The bulk of energy-related investments needs to be attracted to RES and thus (renewable) energy policies need to ensure that the business case for RES is at least as attractive as the business case for conventional energy sources. The financial crisis adds to the challenge of directing capital to the RES sector.

Besides attracting sufficient capital to RES, the challenge for (renewable) energy policies is to minimize RES support policy cost. The levers to achieving both objectives in parallel are:

- 1) Increasing internalization of external cost of conventional technologies (emission trading, energy and emission taxation, emission performance standards, etc.).
- 2) Applying best practice policy design that triggers cost reductions and avoids windfall profits.
- 3) Applying policies that reduce risk, as the risk for debt and equity providers in an RES project is the central parameter influencing availability and cost of capital. Typical risks are related to e.g. policy stability, technology risks, exposure to fluctuating revenues from electricity or green certificate sales, fluctuating biomass feedstock prices, uncertainty from permitting and grid integration.

In this section, we focus on the third lever: What policy options are available to increase capital availability and to reduce cost of capital?

Below a preliminary list of the **most effective policy options to reduce cost and increase availability of capital** is given. The list is based on literature and interviews conducted with stakeholders involved in RES financing in various technologies and member states. During the project<sup>18</sup> it will be further discussed, quantified and detailed: By how much can these policy options reduce cost of capital, generation cost and policy support cost? As some policy options imply a shift of risk from the RES project to the public, a complementary discussion is needed: Which party (project/public) can bear a specific risk at least macro-economic cost?

#### Standard in best-practice systems

- Avoid unexpected or retro-active policy changes
- Guaranteed grid connection and priority dispatch
- Implement technology-specific policies
- Administrative processes short and transparent

#### EU action

- Strictly enforce and monitor compliance to the 2020 RES targets and national renewable energy action plans
- Increase the provision of equity, debt and guarantees by European institutions, e.g. EIB
- Intensify coordination and cooperation between member states, e.g. by the enhanced use of the cooperation mechanisms defined in the RES Directive

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<sup>18</sup> Final results will be published mid-2011 on [www.reshaping-res-policy.eu](http://www.reshaping-res-policy.eu).

### Choice of support system and complements

- In order to create stable revenue streams fixed feed-in tariffs (FIT) are superior to feed-in premiums (FIP)<sup>19</sup> and both are superior to quota obligations
- Publicly backed guarantees (credit or equity)
- Availability of standardized risk assessment tools and ratings
- Government action to increase availability of insurance for risks that are so far not insurable
- Soft loans
- Avoid need for large capital commitments by project sponsors long in advance (for permits, grid connection, etc.)

### Support-system-specific design details

- FIT/FIP: no (annual) budget or capacity cap
- Support financed via surcharge on electricity consumer tariffs instead of state budget
- Quota: use of headroom or minimum certificate price
- FIP/Quota: measures to improve availability and conditions of power and certificate off-take
- Quota: long time horizon and serious penalties
- Front-loading the support payment stream (also possible via investment subsidies or flexible depreciation in tax law)
- Tenders: removing/sharing part of the price risks
- Compensation for forced curtailment and grid breakdown

### Wind-off-shore-specific

- TSO responsible/pays for grid connection
- Temporary government participation (generally in innovative projects)
- Site concessions for at least 30 years

## 5.5 EU debate on harmonisation of RES support

A possible harmonisation of RES support has been forming a central element in the European RES policy debate, specifically for renewable electricity. The new RES Directive as established in 2009 and prominently discussed throughout this report lays the foundation for the RES policy framework until 2020, prescribing binding national targets for RES while the choice of policies to achieve given targets is left to the member states themselves.

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<sup>19</sup> For feed-in premiums a similar stable revenue stream as compared to a fixed feed-in tariff may be reached, when the premium is indexed to an average electricity price.

However, the discussion about harmonisation has been prolonged and several studies have discussed possible efficiency gains arising from that. In April 2010 the Institute of Energy Economics at the University of Cologne (EWI) published a study named “European RES-E Policy Analysis - A model based analysis of RES-E deployment and its impact on the conventional power market” (Fürsch et al., 2010). This study which has been discussed quite prominently throughout Europe analyzed possible efficiency gains arising from a harmonisation of national RES support schemes. The EWI study estimates that a harmonised European certificate trading scheme (*HQS, Harmonised Quota Scheme*) would result in cumulative cost savings for achieving the European 20% RES target of about € 174 billion.

This contradicts the findings of our own previous RES policy assessment, i.e., the recently completed European research project futures-e (see Resch et al. 2009). Consequently, within the RE-Shaping study we conducted a comparative assessment of both studies, aiming to identify similarities as well as differences in the methodologies applied and the results gained, and, moreover, to find explanations for the contradictory conclusions. The key findings of this comparative analysis<sup>20</sup> can be summarized as follows:

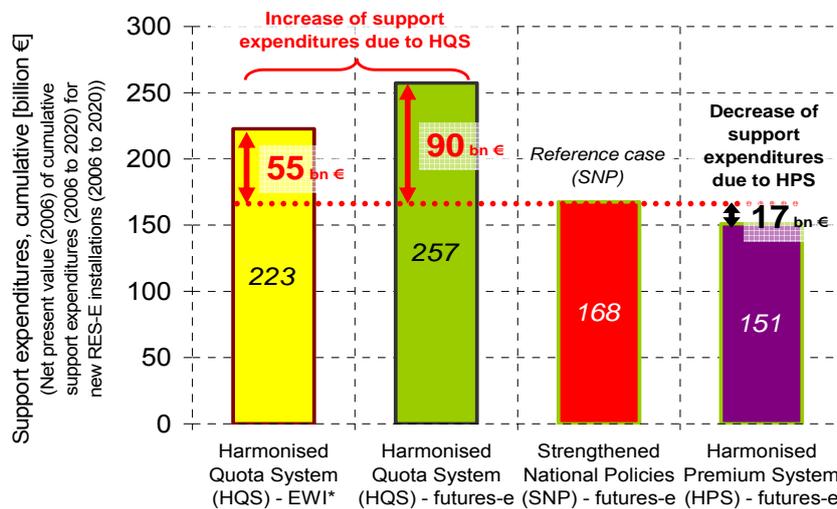
- The EWI study is not based on a reference case which adequately considers the present European policy situation. The EWI study does not define a reference case in line with current realities. The underlying “Business as Usual” scenario used by EWI, which serves as a benchmark to assess harmonisation gains, ignores the implementation of the Directive (2009/28/EC), especially with regard to the cooperation mechanisms contained therein which aim to contribute to an optimized resource allocation all over Europe.
- The EWI study overestimates the exploitable potential of best resources across Europe, since it does not adequately consider the limiting effect of non-economic barriers. Particularly, it does not take obstacles regarding grid expansion into consideration. This leads to unrealistic assumptions for RES deployment at preferable site conditions. For example, EWI assumes that the RES share of Ireland could increase from currently 9% (2007) to 92% by 2020 or that the RES share of Estonia could increase from 1% (2007) to 79% by 2020. In comparison, the futures-e study, while taking non-economic barriers into account, arrives at an estimated RES share by 2020 of only 30% for Ireland and 20% for Estonia.
- The EWI study does not adequately consider that technological learning of RES technologies needs to be financed. Technology learning effects seem to “fall from heaven” - i.e. it appears not to be correctly correlated to “actual” (i.e. projected) RES deployment. In the scenario calculated in the EWI study also currently high-cost technologies such as photovoltaics are needed in the last years up to 2020 in order to

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<sup>20</sup> The full report “Quo(ta) vadis, Europe? - A comparative assessment of two recent studies on the future development of renewable electricity support in Europe (EWI and futures-e)” (Resch et al. 2010) is accessible at the RE-Shaping homepage.

achieve the 20% RES target. Nevertheless, the RES certificate price is assumed to be only 51 €/MWh. This would not be sufficient to finance PV deployment at current PV costs, which results in the assumption that technological learning was modelled exogenously, and, consequently, the overall investment and generation costs as well as the required support in the harmonised quota scheme are calculated too low.

- All in all, EWI’s calculated savings of generation costs due to a switch to the harmonised quota system (HQS) seem to be largely overestimated. The EWI study arrives at lower generation costs of € 174 billion (cumulative until 2020) for reaching the 2020 RES targets compared to their reference case of national RES support. In contrast to EWI, the futures-e study shows cumulative savings in terms of generation costs for a harmonised technology-neutral RES support of only € 7 to 28 billion, depending on the national policy case being compared to.
- More importantly, the EWI study only reflects investments and generation costs - the decisive policy costs for consumers are ignored. If the EWI study had taken into account the producer surplus in a harmonised quota scheme and, thus, the resulting policy costs - i.e. the support expenditures that need to be borne by consumers, this would probably have led to quite different results.
- We can conclude from this comparative assessment that a switch to the harmonised quota system based on technology-neutral RES support would result in an increase of support expenditures compared to the adequate reference case of strengthened national RES support (complemented by cooperation mechanisms). As shown in Figure 5-1, the cumulative “efficiency losses” resulting from that simplified harmonisation range from € 55 to 90 billion, depending on which study (EWI or futures-e) is referred to.



Note: \*Estimated based on expressed certificate prices in 2020

Figure 5-1: Comparison of cumulative support expenditures for new RES-E technologies (installed 2006 to 2020) at EU level according to the assessed policy cases (in line with the 2020 RES targets)

Source: futures-e & own calculations based on EWI

Consequently, a harmonisation of RES support based on simplistic policy options offering uniform support, e.g. via a uniform RES certificate trading, cannot be recommended. Thus, considering the possibilities offered by the RES directive, we can conclude that a further strengthening and fine-tuning of national RES support instruments appears preferable, whereby a main focus should be to remove currently prevailing non-economic constraints which hinder an accelerated RES diffusion. Furthermore, emphasis should be placed on improving the coordination of policy design and tariff definition among EU member states.

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## Abbreviations

CHP	combined heat and power
EC	European Commission
ETS	emission trading system
EU-27	European Union comprising 27 member states
FIP	feed-in premium
FIT	feed-in tariff
HQS	harmonised quota system
MS	member state
NREAP(s)	National Renewable Energy Action Plan(s)
RES	renewable energy source(s)
RES-E	electricity generation from renewable energy sources
RES-H	heat from renewable energy sources
RES-T	transport fuels from renewable energy sources
RO	renewable obligation
ROC	renewable obligation certificate
TGC	tradable green certificate(s)
TSO	transmission system operator

*This report*

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***RE-Shaping***

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